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Contents.

	PAGE
Is Silicosis a Foundry Disease?	237
An Entity or a Department	237
Correspondence	238
German Steel Castings Syndicate	238
A Foundry Congress at Paris	238
Random Shots	238
The Phenomena of Corrosion of Iron and Steel	239
Large Foundry Gathering at Newark Works	241
Ironfounder Adopted as Parliamentary Candidate	242
World's Largest Silver Bell	242
Sheffield Foundry Trade Technical Society	242
Fuel Conference Delegates Visit Derby Foundry	242
Institute of British Foundrymen	242
Notes on Patternshop Management—VI	243
A Chapter of Iron Trade History	244
Temperature Measuring of Molten Cast Iron	245
The Relationship of a Foundry to an Engineering Works	248
Trade Talk	254
Company Meeting	254
Obituary	254
Personal	254
Reports and Dividends	254
Contracts Open	254
Institute of Metals	256
Iron and Steel Markets	256

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

OCTOBER 6.

Wales and Monmouth Branch:—Smoking concert at Cardiff.
Lancashire Branch:—Opening meeting at Manchester. Presidential address by E. Longden. Lecture by Professor F. Johnson, D.Sc., on "Oxygen and Metals: Some Features in their Relationship."
West Riding of Yorkshire Branch:—Presidential address, at Bradford, by W. G. Thornton.

OCTOBER 13.

Lancashire Branch (Burnley Section):—Opening meeting at Burnley. "Practical Application of Science to Motor Cylinder Making." Paper by W. West, of the Leyland Motors, Limited.

Is Silicosis a Foundry Disease?

It is well known that workers engaged in certain industrial processes involving exposure to silica dust may contract a disease due to the effect of silica dust in the lungs. This silicosis may or may not be accompanied by tuberculosis. In two industries, the refractories industry, where ganister is mined or silica and other refractory bricks are being made, and in the metal-grinding industry, it has been necessary to provide machinery for compensation to workmen who contract the disease. A draft scheme is also in preparation for the pottery industry. The Home Office has evidence of risk in other processes where silica has to be dealt with, and the Home Secretary has been urged both in and out of Parliament to extend the right of compensation to workers engaged in any occupations which render them liable to this complaint.

As early as 1907 it was decided that silicosis was a specific trade disease which required compensation, but there are difficulties in the way of treating it under the ordinary provisions of the Workmen's Compensation Act. It is very difficult to diagnose in the early stages, and its development is very slow. In the schemes mentioned above, therefore, special provisions are made, including the establishment of a Trade Compensation Fund and periodic medical examination. The Home Office has not been able to arrange special schemes for other industries in which the risk of silicosis is likely, and consequently proposes a comprehensive scheme to cover all industries, other than refractories, metal grinding and pottery, which involve the risk. Our attention has been drawn to the draft scheme, and it certainly seems that iron and steel founding and non-ferrous founding would come under its provisions, since it covers in a very broad way the handling, moving, breaking, crushing, grinding, sieving, mixing, packing of ganister, silica rock, sandstone, etc. Moulding sand consists in the main of silica, but within our experience, and within that of several experienced founders whom we have been able at short notice to consult, *we have yet to learn of a workman being incapacitated by silicosis.* While no employer would wish to interfere with proper provision against industrial risks which are proved, there is nothing to be gained, and under present industrial conditions, a great deal to be lost, by inflicting on the industry an Order which inevitably will increase the working costs.

One very obvious reason for the absence of the disease is due to the fact that moulding sands and ganisters are never handled in foundries in the bone-dry condition.

The Order in its present form, which, of course, is only a draft, provides for compensation in cases of death or total disablement, but there is not the slightest doubt that as soon as the difficulties of diagnosis referred to above can be overcome the Order will be extended to partial disablement. Objections have to be submitted in writing by October 15, 1928, to the Home Office, and we would urge those with any experience of this matter to communicate their observations to us. In the absence of a reasonable volume of evidence of a positive character, it would seem incumbent on the Secretary of State to produce evidence of the prevalence of the disease in iron, steel, non-ferrous and malleable founding before these establishments are included in the Order. In its present form they would certainly come under it, for while the Act is limited to materials containing 80 per cent. total silica, this would certainly include moulding sands.

Any information forwarded will be placed at the disposal of the employers' organisations, which have the matter in hand.

An Entity or a Department.

Mr. Walker, in his article on "The Relationship of a Foundry to an Engineering Works" (printed elsewhere in this issue), puts forward some interesting arguments in favour of the creation of foundries as departments of other industrial establishments, but we insist that this is a retrograde step on the following grounds. Primarily it operates against the national realisational that foundry work is a basic industry and prevents the presentation of its problems and aspirations as a united whole. Another serious aspect is that in general the foundry department lowers the average market price of castings, because when the owning-firm's section of industry happens to be slack, it succumbs to the temptation to retain their skilled men by competing against the independent foundry. We can instance, for example, shipyard foundry departments making textile and tobacco machinery castings, to say nothing of brake blocks.

Whilst many engineering works have splendidly-equipped and well-managed foundry departments it can be postulated that they do not excel either in equipment, in economy of production, or in quality the best of those run independently.

There is more likelihood of mental stagnation in a department than in a complete industrial organisation, as amongst a number of customers some will be more exacting than an associated machine shop.

We are cognisant that many concerns style themselves "engineers and founders," but cannot call to mind any establishment reversing the order and designating themselves "founders and engineers," yet that is often the truer and more logical appellation. Finally, before any engineer accepts the first four of Mr. Walker's five reasons for installing a foundry and acts upon them, we suggest he should take the following steps: (1) Try for a period of, say, one or two years the employment of a high-class buyer specialised in the puchase of castings. (2) If this fails to satisfy him that the limit of economy and convenience has not been reached, then to float a separate company, having independent finances and management. (3) If satisfaction is still not obtained, then a merger can be effected, and Mr. Walker's excellent rules for its conduct followed.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Cast Iron in Marine Engineering.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with great interest the most interesting Paper by Mr. F. G. Martin, which he read before the Institute of Metals at their recent meeting.

As the Paper was almost exclusively devoted to Non-Ferrous Metals, I suppose it would have been a serious digression if the author had also made some reference to Ferrous Metals.

I note, however, with great interest that he does give the relative percentages of the various metals which go to construct marine engines of different types, from which it appears that the percentage of non-ferrous metals varies from 3¼ per cent. in reciprocating steam engines, 6¼ per cent. in steam turbines, of which 5 per cent. represents the blades, and 7.9 per cent. in Diesel engines. Enormous sums of money in laboratory research and expensive experiment, and much time have been expended on these metals, with no doubt excellent results.

I am, however, personally much more interested in his statements of the percentage of cast iron used, which is given as 58 per cent. for turbines, 41 per cent. for Diesel engines and 70¾ per cent. for reciprocating engines.

It seems to me therefore that at least a little time and some money could be efficiently spent in endeavouring to reduce this high percentage of cast iron in regard to weight and at the same time obtain increased strength.

For over three years marine engineers have had an opportunity of investigating high quality cast irons such as Perlit and Emmel, but as far as one can gather only a few of them appear to have taken advantage of its high qualities by specifying its use. One would have thought that the reduction of weight in marine engines and machinery of all kinds would be a most important factor, especially in view of the increased steam pressures and temperatures and the adoption of Diesel engines, all of which demand special high-quality irons to meet the new and stringent working conditions.

It almost appears that engineers have given up cast iron as a bad job, quite beyond hope of improvement, whereas on the contrary the leading metallurgists on the Continent and especially in Germany, are carrying on continuously and successfully most expensive research relating to the improvement of the quality of grey cast irons. As a result I am informed that nearly all the largest engineering works and foundries in Germany have adopted both the Lanz and Emmel processes, and that all classes of machinery are constantly undergoing drastic structural alterations which render them lighter, stronger and more efficient in all parts subject to high temperatures, pressure, abrasion and other physical strains and stresses.

It is gratifying to find that there are still people in England who at least endeavour to keep in line with progress, and it is to be hoped that sooner or later a practical appreciation of these new and valuable processes will be shown by the marine and other engineers of this country, and of the practical research work done in developing and improving cast irons all of which is so entirely to their advantage.—Yours, etc.,

Progrès.

An Unconscious Disservice.

To the Editor of The Foundry Trade Journal.

Sir,—Your leading article "An Unconscious Disservice" (September 20), quotes the following:—

"It was true that the foundry at the works was only small, and that they did not work to the pressure of a commercial undertaking, *but in the past three years they had had only one waste casting*, and that was rather in the moulding than through any fault in the iron."

This may be perfectly true, but what was the output during the three years? If there were only three castings made in that time, then one waster in three might be quite good practice using ordinary pig-iron for making a simple, common type of casting!

My firm supplies to different parts of the world various kinds and brands of pig-iron, and my information is that the number of waster castings on an average in the general foundry working on ordinary pig and scrap is a higher figure than that you quote from Dr. Moldenke. If it were not so there would be no justification for the relatively high prices paid for some of the high-class Shropshire and South Staffordshire pig-irons.

There is certainly room for improvement in foundry practice and in buying pig-iron on other than mere lowness of price—depending, of course, on the nature of the foundryman's trade.

My experience is that more defective or honeycomb castings will arise from unsatisfactory pig-iron than from bad moulding. But statements such as that which you quote are, as you have pointed out, not helpful.—Yours, etc.,

H. J. Skelton.

Royal London House,
Finsbury Square, London, E.C.

London Metallurgical Societies' Programmes.

To the Editor of The Foundry Trade Journal.

Sir,—As a member of the London local sections of both the Institute of British Foundrymen and the Institute of Metals, I was astounded on comparing the dates of lectures as set out in two current programmes, that in every case the fixtures clash, except, of course, for the December joint meeting. As a considerable number of members, including important officials, are affected, I suggest that if no change can be made this session, it is a matter which must never be allowed to occur again.—Yours, etc.,

S. V. Williams.

22, Mayfield Avenue,
Kenton, Middlesex.

German Steel Castings Syndicate.

According to a report in the "Kölnische Zeitung," forwarded by the British Consul-General at Cologne, it is now intended to form a syndicate for steel castings. Negotiations have been proceeding for some time, and a draft agreement for the proposed association, which will embrace some 60 to 70 works, has been worked out. Sales will start, it is expected, some time before the end of the year.

The association is to control the whole of the production of steel castings, and will take over the sale and distribute the orders received in proportion to the quotas which are to be fixed. It is expressly provided that, with regard to the works delivering, the wishes of clients shall as far as possible be complied with, taking into consideration old business connections. The prices fixed by the association must, however, be adhered to, and the member must report to the syndicate any orders he has carried out.

The direct sale of steel castings for export may continue to be effected by the members independently, and no special prices are provided. The association must, however, be informed of any offers and orders.

Fines are to be imposed for the contravention of any of the provisions of the agreement, which will be valid until December 31, 1933, and shall then be automatically prolonged for another five years, unless notice of termination is given by members at least nine months before the beginning of each quinquennial period.

A Foundry Congress at Paris.

The next Congress to be staged by the French Association Technique de Fonderie will be held on October 26 and 27 at the Ecole Nationale d'Arts et Metiers (151, Boulevard de l'Hôpital). Four sessions will be held, at which various papers of technical and scientific interest will be presented. Amongst these are "Methods of Testing Cast Iron," "Sands," "Standardisation of Patterns," "Malleable Cast Iron," and "The Thermal Treatment of Cast Iron."

Random Shots.

This has been an exceptionally busy week, for a number of events have taken place. I have no doubt that many readers found their way to the Radio Exhibition at Olympia, even if they failed to find time to visit the Machine Tool and Engineering Exhibition the previous week. I am by way of being a wireless enthusiast, and I think the B.B.C. is one of the greatest institutions of this or any other age. It is, in point of fact, a magnificent vindication of the much-maligned university education, and no country in the world possesses an institution like it. It manages to combine a certain degree of what one might call governmental responsibility with a degree of enterprise and imagination which is usually found in first-class commercial enterprise.

* * *

In point of fact, if the Post Office exhibited a fraction of the response to public opinion and new enterprise that is daily evidenced by the B.B.C. a large part of public objection to Government control would disappear. These two institutions serve to give interesting point to the comments of Professor Bragg as given in our last issue.

* * *

Have we not in the B.B.C. a new enterprise which has attracted first-class brains, building up an entirely new industry or public service? This corresponds with the first stage of industrial development in which true craftsmanship is needed, using the term in a very wide sense. On the other hand, the G.P.O. has got to the mass production stage where things have settled down to a stolid matter of fact level of mass production.

* * *

As the article in question pointed out, however, the industry of the mass production stage requires just as much intelligence, imagination and scientific control as the industries which are in the formative period. I would therefore like somebody to tell me how I can get my morning letters ten minutes before rather than ten minutes after I catch my morning train, and how to ensure a telegram being received less than 100 miles away under rather than over two hours, or alternatively why my exchange girl should reply to my meek inquiry in a tone of voice which suggests that I am making quite impossible demands upon her time and temper.

* * *

Did we not hear a short time ago of the Parisian telephone girls giving a dinner-dance to their more disgruntled callers to show them what thoroughly charming and reasonable people they can be when away from the hateful instrument? But French opinion is best shown in a little music-hall sketch I saw of a girl who attempted to commit suicide by throwing herself over the parapet of a bridge and ultimately being rescued by a passing tramp. After some sympathetic interchange the gentleman inquired what the lady did for a living, and on being told that she was "telephoniste," he promptly picked her up and returned her to the river.

* * *

I started out with the most excellent intention of indicating some of the events of the week, which it is the praiseworthy effort of this column to record, including the Radio Exhibition and more particularly the World Fuel Conference in London, not forgetting Len Harvey's bout with Sullivan and similar important events.

It is astounding how one thing leads to another, and if the events recorded above have not received their due share of attention, it is not because they are unimportant!

* * *

Some very funny schoolboy howlers have been seen this week. One of these defined Pluto as "god of the Underground" and "pas de deux" was translated as "father of twins."

Marksman.

The Phenomena of Corrosion of Iron and Steel.*

By A. Herrero and M. de Zubiria (Bilbao).

That the phenomenon of corrosion is of fundamental importance is obvious when one considers not only the enormous tonnage of material which on account of corrosion is annually discarded as scrap, but that 4 or 5 tons of coal, or its equivalent, are consumed per ton of steel, from the getting of the ore to the finishing of the product. It is clear, therefore, that by allowing this to continue instead of attacking the evil at its source, we are depleting our reserves of fuel for which no substitute has yet been found.

Assuming, as a starting-point for subsequent calculations, that the world's annual production of steel is 100 million tons, and that the average life of iron and steel products is 30 years, it means that at the end of that period this enormous production will have been converted into scrap. The scrapping of the greater part will no doubt be due to the fact that the progress of industry necessitates the replacement of many structures or appliances by others more economical or more accurate. But there nevertheless remains a large proportion amounting to millions of tons, the deterioration of which is due to corrosion alone, and when that tonnage is converted into terms of fuel consumed in its production the loss of combustible alone assumes startling proportions.

It seems paradoxical that stone and wood, though much less resistant to mechanical stresses than metal products, are much better able to withstand atmospheric influences. Moreover, it is a curious fact that as the demand for steel increases and as the capacity for its production on a large scale is ever growing, the relative amount annually wasted by corrosion also increases; that is to say, with more intensive manufacture the inferiority of the product with respect to its resistance to corrosion appears to be on the increase.

This circumstance is well known to those who have to devote their attention daily to the products of our own time. It is a well-known fact that the iron and steel products of ancient origin were much less susceptible to atmospheric corrosion than are modern products, though none of them is entirely incorrodible, not even the famous column of Asoka at Delhi. This latter, which has remained unchanged for centuries, owes its preservation to a kind of fine coating, possibly slag, which originated in the process of manufacture, the removal of which would cause the pillar to corrode, though the progress of corrosion would be exceedingly slow.

That the atmosphere exerts a great influence is obvious from the fact that the common metals always occur as oxides, sulphides, sulphates, or carbonates, and scarcely ever as native metal, except those such as gold and platinum, which are not susceptible to atmospheric corrosion. The metallurgist in extracting the metal from its oxide is really exerting himself to undo that which the slow action of the atmosphere has brought about, and although he has found a means of succeeding in this his triumph is apt to be short lived, since the metal purified with such labour and expense soon tends to revert to the state of oxide, sulphide, sulphate, or carbonate from which it had been extracted.

On the other hand, it is evident that in the problem of corrosion readily corrodible substances may play an important part in this sense, that, since metallurgical products are never pure metals but are always alloys, it is evident that their chemical composition and their greater or less degree of homogeneity may be of influence in stimulating or delaying atmospheric action. It is equally certain that their physical state, microstructure, and condition of internal stresses are factors which influence the atmospheric effect to a greater or less degree.

Having thus sketched out the problem it is clear that the subject is endowed with extraordinary interest, not only on account of the destruction of the iron, which if rusted can at all events be remelted and used again in some other form, but on account of the fact that the fuel consumed in its production can never be recovered, and no economic substitute is known at present. In countries with progressive industries this fact has been recognised, and in recent years centres of research have been established to study the problem of corrosion. Numerous researches have been carried out at the Bureau for Testing Materials at Berlin and at the Institution subsidised by Carnegie in the United States. The Faraday Society in England has published a collection of reports thereon. In Germany a Committee known as the Reichausschuss für Metallschutz has been formed, whose organ, *Korrosion und Metallschutz*, summarises the results of corrosion research carried out in all countries. In England the Institute of Metals, and in America the Institute of Mining and Metallurgical Engineers, devote themselves largely to the problem of corrosion, and publish results of research work thereon.

The Iron and Steel Institute, the most widely known organisation in regard to all that relates to the manufacture of iron and steel, follows the general rule. That Institute includes on its roll the leading metallurgists and chemists who have devoted attention to this question of corrosion, and many important contributions on the subject are to be found in the pages of its publications.†

The results of all such work have become available to us in Spain, and some of the principal Spanish metallurgists and engineers are now manufacturing the so-called rustless steels. That is to say, the study of the problem of producing steels resistant to corrosion by external agents is definitely established as a national one in Spain.

Nevertheless, it is not this aspect of the problem which so much occupies the attention of the metallurgist at the present day, for if the only remedy against corrosion were to be found in the use of special non-rusting steels, the high cost of these would greatly restrict their application. The ordinary steel structures, such as bridges, structural steel for buildings, hulls of ships, railway material, etc., could never be built of such expensive material. The whole problem is a much wider one, and is not capable of so simple a solution. The main point is that any economic solution of the question must be such that will not raise the price of ordinary commercial steels above that at which they must of necessity be sold. It is this aspect of the problem which has been the subject of much study for several years, and upon which much has been written.

In the belief that the matter is one of special current importance, the authors venture to set forth briefly the theories of the corrosion of metals. They would mention as a singular coincidence, in support of which they have plenty of evidence, that in Spain the atmospheric conditions appear singularly adapted for producing their destructive effects.

Theories of Corrosion.

If among the elements of which the earth is composed the metals were simply in a state of metastable equilibrium, which as a matter of fact is never the case, since the metals always occur as oxides or salts due to their prolonged contact with natural agents such as water, oxygen, carbonic oxide, etc., it is evident that the principal and true cause of such transformations would be atmospheric action alone. It is easy enough to indicate the disturbing element. The difficulty arises in defining how and when such action proceeds, and more particularly in determining the causes which tend to promote atmospheric action, causing a metal to lose its character and to change into a salt or an oxide, overcoming the inertia opposed to every such transformation, and, on the other hand, in finding the means for encouraging this inertia and thus impeding corrosion.

Two theories in explanation of the phenomenon of the corrosion of metals have found a following—namely, the electrolytic theory, held particularly in the United States by Cushman and Walker, and the chemical theory, championed in Europe by Heyn, Friend and others.

According to the former theory, corrosion is due to the formation of local galvanic couples due to the existence in the steel of local differences of composition, impurities, or internal stresses. The defenders of the chemical theory, on the other hand, affirm that the oxidation of a perfectly pure and unstrained iron may take place in water without the intervention of any electrolyte whatever. Nevertheless, these latter admit that the absence of galvanic couples, when the before-mentioned causes to which they are due disappear, delays the initiation of oxidation but does not prevent it, once initiated.

Fundamental Facts.

(1) That iron does not corrode in dry air, that is, unless moisture is present. Proof of this is afforded by the fact that in certain regions in Egypt and India, where the air is almost entirely lacking in moisture, metals do not corrode appreciably, while if the same articles are transported to other localities where the air is charged with moisture, corrosion will set in at the ordinary intensity.

(2) That iron will not corrode even in moist air so long as no precipitation of water upon it occurs. Among other proofs of this fact perhaps the most striking is that steam-turbine blades, working in superheated steam, are not subject to appreciable corrosion in those places at which the temperature of the steam, and in consequence that of the blades, is high enough to prevent the condensation of moisture upon them. On the other hand, corrosion is set up normally in other parts where the blades are exposed to a temperature sufficiently low to enable the steam to condense upon them.

(3) That iron does not corrode in pure water if no air is present. The proof of this is the fact that any object of iron or steel partly submerged in water will corrode only slightly on the submerged part, but will suffer the maximum corrosion at the level of the water where it is subject to the simultaneous action of the oxygen of the air and of the water.

From the foregoing it may be inferred that to produce corrosion it is necessary always to have an agent which will attack iron—an electrolyte, in fact—and oxygen, and in addition free ions of hydrogen. Given this conception, both the chemical and electrolytic theories will harmonise perfectly, seeing that the former assumes the existence of those elements as being derived from an acid, and the electrolytic, admitting the ionic dissociation, leads to the same conclusion. For the water, however pure it may be, will always contain a small quantity of free hydrogen ions—that is to say, it would always be acid in character and action. From this it may be agreed and admitted that the process of corrosion is always electro-chemical in character, the ionic theory being fundamental for its practical explanation, and in the academic sphere it may be left to the defenders of either theory to discuss the precise causes.

As a curious circumstance in this connection it may be mentioned that there is a biological theory which has found support in some quarters. That is, that corrosion of iron is to be attributed to certain micro-organisms, but although it is beyond doubt that cases of corrosion by organic agents have been met with, it does not appear that such agents could be nourished on iron. If such a thing were possible it would only be by bringing the iron first into solution by means of some acid secretion, which brings us back to the acid theory. Nevertheless, these curious cases have occurred in organic salts of iron, and the action of the micro-organisms can only have been that of assimilating, not the iron, but the organic base of the salt, leaving the iron free in the form of ferrous hydroxide, thus exhibiting the phenomena

* A Paper presented to the Bilbao Meeting of the Iron & Steel Institute.

† In June of the present year a Committee on the Corrosion of Iron and Steel was constituted, which is a joint committee of the Iron and Steel Institute and the National Federation of Iron and Steel Manufacturers, and it forms one of the technical committees of the Iron and Steel Institute.

which explain the acid and electrolytic theories of corrosion.

Electro-Chemical Phenomena.

Between any metal and a solution of a salt of the same metal of a known ionic concentration there exists a definite and precise potential at which there is equilibrium between both agents. That is, that at a certain voltage the metal will neither pass from the atomic to the ionic state, thus going into solution, nor will the metal that is in solution—that is, in the ionic state—deposit as metal in the atomic state. These potentials of equilibrium differ, as might be expected, from one metal to another, and they also vary within the same metal according to the ionic concentration, the temperature, the pressure, and the condition of the surface.

To render these potentials not only measurable but comparable, the potential of hydrogen is taken as the standard—namely, that which exists between platinum saturated with hydrogen and an acid solution of normal hydrogen-ion concentration at a pressure of one atmosphere. This standard of reference serves as zero in the scale of the electro-chemical series or electro-potentials of various metals.

Without going too much into detail, attention is directed to the accompanying Table I showing the potentials referred to. The table shows that the "precious" metals occupy the highest position among the positive potentials, while the alkali metals are at the opposite extreme corresponding to the maximum negative potentials. From this it is inferred that the precious metals are very easily reducible, for in whatever solution they exist they will precipitate, passing from the ionic to the atomic state, on being placed in contact with a metal of lower potential. The alkali metals, on the other hand, which belong essentially to the group of metals of high reactivity, when brought into contact with salts of other metals will dissolve readily, passing from the atomic to the ionic state.

It will be noticed that iron occupies an intermediate position in the electro-chemical series, but its potential is negative with respect to the hydrogen standard above referred to, and its negative character is sufficiently accentuated. It is, in fact, a metal with a tendency to enter into ionic solution, and accordingly is susceptible to corrosion if the conditions are favourable.

Table I.—*Electro-Potentials of Various Metals.**

Metal.	Ion.	Ionic Concentration.				
		N.	*N*/10.	*N*/100.	*N*/1,000.	*N*/10,000.
		Volt.	Volt.	Volt.	Volt.	Volt.
Gold	$Au^{\cdots}$	+ 0.99(?)	—	—	—	—
Platinum ..	$Pt^{\cdots\cdot}$	> + 0.86(?)	—	—	—	—
Silver	$Ag^{\cdot}$	+ 0.7987	+ 0.741	+ 0.683	+ 0.625	+ 0.567
Mercury ..	$(Hg^{\cdot})_2$	+ 0.7928	+ 0.764	+ 0.735	+ 0.706	+ 0.677
Copper	$Cu^{\cdot\cdot}$	+ 0.3469	+ 0.318	+ 0.289	+ 0.260	+ 0.231
(Hydrogen) ..	$H^{\cdot}$	± 0.000	− 0.058	− 0.116	− 0.174	− 0.232
Lead	$Pb^{\cdot\cdot}$	− 0.132	− 0.161	− 0.190	− 0.219	− 0.248
Tin	$Sn^{\cdot\cdot}$	− 0.146	− 0.175	− 0.204	− 0.233	− 0.262
Nickel	$Ni^{\cdot\cdot}$	− 0.20	− 0.23	− 0.26	− 0.29	− 0.32
Cobalt	$Co^{\cdot\cdot}$	− 0.23	− 0.26	− 0.29	− 0.32	− 0.35
Iron	$Fe^{\cdot\cdot}$	− 0.34	− 0.37	− 0.40	− 0.43	− 0.46
Cadmium ..	$Cd^{\cdot\cdot}$	− 0.420	− 0.449	− 0.478	− 0.507	− 0.536
Zinc	$Zn^{\cdot\cdot}$	− 0.770	− 0.779	− 0.828	− 0.857	− 0.886
Aluminium ..	$Al^{\cdots}$	− 1.337	− 1.356	− 1.375	− 1.394	− 1.413
Magnesium (approx.) ..	$Mg^{\cdot\cdot}$	− 1.8	− 1.8	− 1.9	− 1.9	− 1.9
Sodium	$Na^{\cdot}$	− 2.715	− 2.773	− 2.831	− 2.889	− 2.947
Potassium ..	$K^{\cdot}$	− 2.925	− 2.983	− 3.041	− 3.099	− 3.157

* U. R. Evans, *Transactions of the Faraday Society*, 1924, vol. xix. p. 797.

The electro-chemical phenomena thus outlined present features which will now be discussed in detail.

In some cases reversibility is almost perfect, that is, if the potential falls below the value necessary to maintain equilibrium, cathodic deposition takes place. If it is raised above that value anodic solution and corrosion set in. Both these phenomena proceed instantaneously without any lag according to the reagent which provokes the action—that is, there is nothing in the nature of electro-chemical hysteresis.

On the other hand, there are other cases in which, starting from a potential lower than that of equilibrium and increasing it by successive increments till it reaches and exceeds the equilibrium potential, an immediate reversal does not take place, for a higher potential than the equilibrium may be reached without anodic solution setting in. It will suddenly start after passing a zone of difference of potential which varies according to the circumstances, this zone forming a regular hiatus in which no sensible electro-chemical action takes place. In such cases an over-voltage is necessary to start anodic solution, and as soon as it has commenced the speed of solution falls off in spite of any increase of the voltage, until finally a state of passivity is reached.

Governing Factors in Corrosion.

One of the most interesting illustrations of this effect is afforded by the liberation of atomic hydrogen in the cathodic zones of any metal, iron for choice, for there then exists the hiatus referred to and the over-voltage is also necessary in order to overcome the inertia which causes the electro-chemical hysteresis. In the case of every metal this is a function of the state of its surface, of its electro-chemical history, of the temperature, and of the nature of the cathodic surface, the slightest roughness of which makes more easy the liberation of the hydrogen bubbles and reduces the over-voltage. The present of a depolariser which, like oxygen, will combine with hydrogen will have the same effect. In all such cases the removal of the hydrogen in the one or other form will reduce the hysteresis, and to that extent will cause the electro-chemical phenomena to manifest themselves more readily. In developing their subject the authors wish to emphasise these characteristics, in view of the importance of the question of the corrosion of iron.

It may be clearly deduced that in order to produce the phenomena of corrosion it is essential that the electro-potential of hydrogen should be higher than the sum of the potential of the iron and the over-voltage imposed by the presence of the cathodic zone in which the bubbles begin to form. In the contrary case the current, and with it the corrosion, ceases.

Referring again to the table of the electro-chemical series, it follows in accordance with what has been stated that the electro-potential of the metals which occupy the lowest position in the series—that is, the alkali metals—is so small in comparison with that of hydrogen that their presence in an acid solution provokes the ready liberation of hydrogen, whereas in the case of the precious metals of a much higher electro-potential than that of hydrogen such a reaction is impossible.

Iron, as has been stated, occupies an intermediate position in the series, but the fact that its electro-potential is considerably lower than that of hydrogen explains that the same thing occurs as with the alkali metals, though with less intensity. For the consequent over-voltage and hysteresis which may be caused by the presence of cathodic zones in the metal will tend to reduce the anodic solution of the iron—that is, the corrosion—if not check it altogether shortly after having set in, on account of the accumulation of bubbles of atomic hydrogen within such narrowly-restricted zones. The cathodic zones referred to may be easily produced by strains in the product, or they may be due to the presence in the iron of other metals, metalloids, or impurities.

In such circumstances the reaction will continue if the liberation of hydrogen is facilitated; but, on the other hand, the consequent over-voltage and the hysteresis would be so great that passivity would be reached and the corrosive action would cease. Thus the two types of corrosion which modern theories admit stand out with marked characteristics—that is, the corrosion with liberation of hydrogen in bubbles and corrosion with elimination of cathodic hydrogen by means of a depolariser, which in general is oxygen, or in special cases may be some other oxidising agent. The first implies, nevertheless, a rapid displacement of hydrogen which would not take place unless acid solutions in contact with iron came into play. That, however, does not correspond to the normal process of corrosion in the wider sense, which is simply the corrosion produced by atmospheric agents under ordinary conditions.

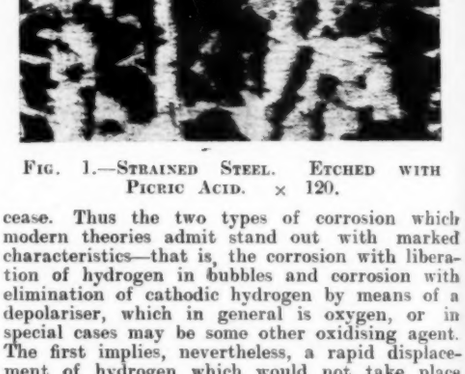

Fig. 1.—Strained Steel. Etched with Picric Acid. × 120.

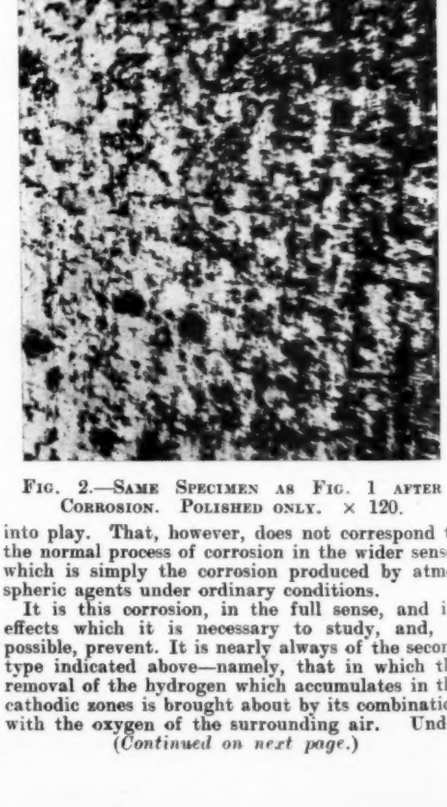

Fig. 2.—Same Specimen as Fig. 1 after Corrosion. Polished only. × 120.

It is this corrosion, in the full sense, and its effects which it is necessary to study, and, if possible, prevent. It is nearly always of the second type indicated above—namely, that in which the removal of the hydrogen which accumulates in the cathodic zones is brought about by its combination with the oxygen of the surrounding air. Under

(*Continued on next page.*)

Large Foundry Gathering at Newark Works.

Probably never since the formation of the East Midlands Branch of the Institute of British Foundrymen has the opening meeting of any session been attended with such complete success as that held at Newark on September 23, when there was an attendance of 160 members, representing all parts of the area. The meeting had been arranged in conjunction with the Sheffield and West Riding Branches, which were represented by their respective Presidents and a large contingent of members, who travelled by road in specially chartered chars-a-banc. The attraction at the ancient town of Notts was a visit to the works of Messrs. Worthington-Simpson, Limited, which had been arranged by the honorary secretary (Mr. H. Bunting), of Derby. By 3 p.m. the majority of the members had arrived at the works, and after being detailed off in sections were placed in charge of the managers of the firm's various departments, who conducted the members over the works to explain the many interesting plants.

The works of Messrs. Worthington-Simpson are very large, and, at the present time, the firm is carrying out one or two exceptionally big contracts. Every department was visited, and much that was of interest was seen and fully explained. A start was made by a visit to the pattern-making shop, which indicated that business was somewhat brisk. There was much to interest here, but a longer halt was made in the extensive moulding shop where machinery was seen in motion. This had been arranged for the benefit of the visitors by Mr. Graham, who had very kindly given instructions for certain workmen to be in attendance to operate the machines and demonstrate their usefulness. The large sand-mixing machine commanded much attention, and, as the various sections of the party went to see this device at work there was an experienced member of the firm's staff in attendance to explain the functions of the sand mixer and to tell with expert knowledge how this machine separated the various materials and distributed them through their right channels so that only the prepared sand was retained and finally discharged down a shoot into a wagon which conveyed the sand away each time it was filled.

Another interesting machine in the moulding shop was the sand slinger, which is, without doubt, one of the greatest assets in a large foundry. To see this in operation was quite a new experience for many of the visitors, who spent much time in seeing the machine carry out the duties that are expected of it. One man operates the machine, which, although it seems cumbersome to handle, is worked quite easily. The tour round the erecting shop was also full of interest. There was a large pumping machine, a contract from Brighton, just complete, and was being tested prior to despatch. The various points about the engine were explained in detail. Other departments inspected included the brass finishing and machine shops.

Subsequently the party adjourned to the firm's mess rooms, where the members were entertained to tea by the firm, the proceeding being presided over by Mr. J. T. Graham, general manager of the firm, who was supported by Messrs. S. H. Russell (President of the Institute), J. Lucas (Branch Vice-President), H. Moore, J. T. Goodwin (Past-President, Sheffield), W. G. Thornton (President of the West Riding Branch), Stevenson and H. Bunting (Derby, Hon. Secretary of the East Midlands Branch).

Lessons from Abroad.

In extending a welcome to the members, Mr. Graham said it was indeed a great pleasure to him and also the firm to have the honour of entertaining such an excellent gathering of foundrymen. He hoped the tour of inspection through the various departments of the works had been interesting to them, "and," he added, "if you have seen anything that is going to be of service to you then we shall feel that something has been done." The foundry business is a difficult problem; in fact, he had always sympathy for a foundry foreman. "I have more sympathy with him than any other member of the foundry business. First of all he is a producer, for he has got to start at the beginning and produce something that will be satisfactory in the end." There were many times when very hard things were said about a foundry foreman—but, by other departments. (Laughter.) During the last few years they had endeavoured to try and re-organise their foundry. It was one problem starting with a clean sheet, and it was another problem starting to add to. The buildings, of course, required to be altered for one thing and another, and they did not always appear to be satisfactory, for you do not always get a satisfactory solution in the end. "I have been on visits to Continental foundries and also foundries in America, and some of the work turned out was not always better, despite the superior equipment that was used." There were, he admitted, many things to learn abroad—how to do and how not to do—and if they avoided the things "not to do" then, perhaps, they could get a satisfactory solution to the foundry problem.

He assured them that their presence in Newark that day had been just as much pleasure to him and the firm, as what he hoped it had been to the members of the Institute. When he first heard from Mr. Bunting with regard to the visit the honorary secretary said he thought there would be about 80 visitors, but a second letter stated there would be 120, but even this number had been exceeded by about 40. Still, at the same time, he was extremely pleased to have had the opportunity of welcoming such a distinguished gathering. He understood that was the opening meeting of the session, and there was everything to indicate a very bright term. In conclusion, he said: "We have been delighted to have you here to-day, and I must also thank the firm's staff in having stayed behind to conduct you round the works. (Hear, hear, and applause.)

Vote of Thanks.

Mr. Lucas (Senior Vice-President) briefly returned thanks to Mr. Graham, and said that as the meeting was a combined one, inasmuch as it included members of the Sheffield and West Riding Branches, he thought that it would be better for Mr. S. H. Russell, as President of the Institute, to respond.

"We have to thank you very much indeed for the splendid facilities you have afforded us to-day to visit your very interesting works," said Mr. Russell, who said that everything had been intensely interesting. On behalf of the foundry foremen he also wished to thank Mr. Graham for the sympathy he had with them. The foundry foreman had many problems to solve, and also many difficulties to overcome. That day they had been particularly interested in the way in which Messrs. Worthington-Simpson had adopted the modern plant in not what he would exactly term old, but rather existing buildings. It was one of the biggest problems to-day to use modern appliances in old buildings, but Worthington-Simpson's seem to have solved it in a very satisfactory way. "We have seen alterations and read descriptions of your work in The Foundry Trade Journal, and we all knew that we were going to see something modern, and I can say we have not been disappointed." It had also been a pleasure to have seen the plant in motion, and it was, indeed, very considerate of the firm to have arranged for this. It was very seldom they had an opportunity of seeing foundry machinery in operation on a Saturday afternoon. With regard to Continental and American foundries which Mr. Graham had referred to, and the things that they could learn to do and what not to do by such visits, he declared that the same point applied in visiting foundries, even in our own country, and he thought they had all learned something that day. On behalf of the members of the Institute he wished to express thanks firstly to the directors of the firm for so very kindly entertaining them that day, and secondly to the members of the staff who had given up their half-holiday in order to conduct the party round the works. They all appreciated it very much indeed.

After tea the gathering adjourned to the firm's lecture hall to hear an address on "Experiences in Continental Foundries," by Mr. J. Arnott, of Glasgow. Mr. Russell occupied the chair, and, after introducing the lecturer, who, he said, had made a long journey from Glasgow that afternoon and was returning that night, presented two diplomas which had been won by members of the Institute for the best Papers read. One diploma was awarded to Mr. H. J. Beckett, of Derby, and the second to Mr. P. A. Russell, of Leicester, the latter gentleman being a brother of the President of the Institute. Mr. S. H. Russell offered his congratulations, and each of the recipients returned thanks.

Mr. Arnott, who received a splendid reception, told the gathering that he had visited both Swiss and French foundries, and, after a reference to the customs of the people, he went on to explain in detail the working conditions of two firms, and, in an interesting manner, told of how the two buildings were equipped. In a few instances he compared these with foundries at home. The address was made the more interesting by a number of lantern slides showing how moulds are made.

The Phenomena of Corrosion of Iron and Steel.

(*Continued from previous page.*)

such conditions an aeration, varying from one zone to another, might, in combination with other factors tending to set up corrosion, cause the rapid removal of the hydrogen in the aerated zones, which, being cathodic, will not be subject to corrosion so long as this phenomenon proceeds intensively and uninterruptedly in the anodic and non-aerated zones.

This explanation is nevertheless incomplete, unless account is taken of the phenomena which proceed in the anodic region, which is that of corrosion, even when on occasion the deposit formed there is of so low a solubility that it covers the anode and protects it from further corrosion.

On the other hand, it is certain that the solution of the corrosion product will always leave the anode in a suitable condition for further attack. Thus in the case of iron and steel the presence of chlorides stimulates corrosion in a high degree, for the hydroxide of iron readily dissolves in hydrochloric acid.

Sometimes also the product of corrosion, when deposited upon the corroded surface, may become characteristic of the various forms of corrosion, for there is a marked difference between oxidation in the form of a thin but continuous coating, which, when once deposited, serves as a protective covering and hinders further attack (a typical example is the behaviour of the so-called non-oxidising steels) and a deposit of hydroxide of iron as a permeable and porous coating. In this case the action of the ions in furthering corrosion is limited to the pores of the deposited hydroxide, whereas the electrons can act on the entire surface of the coating. Thus is produced the type of corrosion called pitting, for it is only in these restricted zones that anodic solution can take place.

It may be concluded from all this that in the normal atmospheric corrosion of iron and steel the electro-chemical process will be regulated, given an even distribution of the oxygen, by the electro-potentials of the different parts. This point is emphasised, because an unequal distribution of oxygen may be of such intense influence as to disturb the course of the phenomena in question. In the first place, the presence of heterogeneity in the specimen is sufficient to cause corrosion, whether it be chemical in character (segregations of sulphur or phosphorus, or slag inclusions, presence of graphite, oxide inclusions, etc.), or whether of physical origin, as may happen with strained materials. In the first case just those zones will be cathodic where segregations, inclusions, or impurities are localised, and the remainder will be anodic. In the second instance the more strained zones will act as anodes and will dissolve, while the annealed or less strained zones will be cathodic.

The unequal distribution of the oxygen can, as indicated, completely change, or at least obscure, these results, softening the contrast which otherwise appears to delimit sharply the anodic and cathodic zones.

(*To be continued.*)

Ironfounder Adopted as Parliamentary Candidate.

Mr. J. R. Aiton, C.B.E., the well-known Derby ironfounder, and a member of the East Midlands Branch of the Institute of British Foundrymen, has been adopted as prospective second Conservative candidate for Derby, at present represented in Parliament by Mr. J. H. Thomas and Sir Richard Bruce.

At the meeting, Mr. Aiton, in reply to his unanimous adoption, expressed thanks to the Association for having extended such an honour to him and assured them that he would work in every way possible with Sir Richard Bruce if returned. "I am of a fighting nature," he added.

Mr. Aiton, who is well known to the whole of the East Midlands Branch, and also to the members of other Branches of the Institute, is head of the firm of Messrs. Aiton & Company, Limited, ironfounders and pipework specialists, Stores Road, Derby. He was one of the first businessmen in the town, and has done yeoman service for Derby Chamber of Commerce. He was elected chairman of the Derby Conservative and Unionist Association in 1925, and has not spared himself in the work he has had to do for the Association since his election. Mr. Aiton was born at Nagpur, in the Central Province of India, in 1864, and, after being educated in London and Scotland, was apprenticed as a marine engineer to one of the large firms of shipbuilders in Glasgow. Subsequently, he went abroad, and from 1887 to 1890 served as an engineer on the river Irawadi, in Burma, and from 1892 to 1894 was engaged in shipbuilding in South America.

He began the business of Messrs. Aiton & Company, Limited, at Willesden, in 1906, but later moved to Derby. At that time he was only in a very small way of business, employing not more than a dozen workmen and staff. Since then Mr. Aiton's business has continued to increase, every year having witnessed an addition and improvement, until, at the present time he has not only the Derby works, but other works near Paris. Soon after he established himself in Derby Mr. Aiton became active, not only for the progress and welfare of his own business, but for the town and its trade. On October 30, 1907, he was elected a member of the Derby Chamber of Commerce, and, since then he has been a hard worker. He is chairman of the Derbyshire Provincial Division of Conservative Associations, and some time ago became a member of the Council of the National Executive of the Party. He is also President of the Duffield Conservative Association, and he has filled many other offices, including the Presidency of the Beaconsfield Club, at Derby.

On the death of Mr. Henry Davis, chairman of the Derbyshire Munitions Committee, Mr. Aiton was appointed his successor, and the bulk of the work was done under his leadership. One of the activities of the Committee was the establishment of the Derby Shell Factory. The factory attained the blue riband in the production of the 4.5 H.E. shells, making them at the lowest unit cost of any concern, public or private, in the country. This factory was one of the first of its kind in the country to employ women; although it was commenced with a working staff wholly of men it was finished at the end of the war with a staff having one of the lowest percentages of men in the country. Mr. Aiton directed the employment of the factory, which also manufactured 4.1 "tear" shells, and hundreds of contracts were placed with firms throughout the country for the supply of munitions of war, ranging from ammunition boxes to 2-inch howitzer bombs. About 1,500 women were employed at the factory. Owing to the esteem in which Mr. Aiton was held, the Ministry of Munitions C.B.E. was conferred upon him.

In 1922 Mr. Aiton was chairman of the Foreign and Colonial Affairs Committee of the Associated Chambers of Commerce, and, in that capacity visited South America. In his six months' absence he travelled 16,000 miles. Mr. Aiton attended the 11th Congress of the Federation of Chambers of Commerce of the British Empire at Cape Town in October of last year, where he proposed an important resolution relating to trade barriers.

World's Largest Silver Bell.

Recently we illustrated and described the manufacture of what is thought to be the world's largest silver bell, which has been installed on H.M.S. *Nelson*. We now give a further photograph showing its appearance after engraving by the silversmiths, Messrs. Reid & Sons, of Newcastle. It was this firm which placed the order with Messrs. J. Stone & Company, Limited, of Deptford, who apparently were the only firm in the country sufficiently courageous to undertake the task.

The largest Silver Bell ever made.
Made to the order of Reid & Sons, Silversmiths, Newcastle, by J. Stone & Co., Ltd., Founders, Deptford.

Sheffield Foundry Trade Technical Society.

This Society now enters upon its fourth year. An interesting series of lectures and discussions has been arranged details of which will be published from time to time in our columns. Mr. J. Emmott is this year's president and Mr. W. H. Bolton, Department of Applied Science, St. George Square, Sheffield, the secretary.

Fuel Conference Delegates Visit Derby Foundry

During the past week-end a number of German delegates to the World Fuel Conference in London paid a visit to Derby. They received a welcome at the works of the Combustion Engineering Company, where they had the opportunity of being conducted over the foundry and other departments, which they admitted was very interesting. Everything was explained to the visitors by their guides, and at the close a hearty vote of thanks was accorded the firm and directors for having so kindly conducted them round the works.

The British Drying and Heating Company, Limited, have changed their address from 14, Waterloo Place, S.W.1, to 15, King Street, London, S.W.1. The telephone number is Gerrard 4161, whilst the telegraphic address remains unchanged as "Britdriet Piccy, London."

Major, Robinson & Company, Limited, have changed their address from "Scols" Works, Sykes Street, Chester Road, Manchester, to 385 and 387, City Road, Cornbrook, Manchester, where they have installed the latest plant in order to turn out the highest quality of iron cement, whilst ensuring a more efficient and prompt service to their customers. The new telephone number is Trafford Park 1760, whilst the telegraphic address remains unchanged as "Blowpipe, Manchester."

Institute of British Foundrymen.

Sheffield Branch President and Cheaper Iron.

So successful has the opening meeting of the session of the East Midlands Branch of the Institute of British Foundrymen proved, that the honorary secretary (Mr. H. Bunting) is expecting a gathering quite as large as that which attended Newark, at the meeting to be held at Loughborough on October 27, when Mr. J. Lucas, a vice-President of the Branch, will give an address on "Foundry Costing."

In connection with the recent Newark meeting Mr. Goodwin (President of the Sheffield Branch), who is a past-President of the Institute, has paid a very high tribute to Mr. J. Arnott, of Glasgow, on his very instructive address. Unfortunately, a full report of Mr. Arnott's speech could not be given, owing to the fact that it concerned certain foundries abroad, and permission is still awaited from the proprietors of the Continental foundries in question. This was a big disappointment to the 160 foundrymen who attended the meeting, but, however, as permission is expected to be given shortly, a full report will appear in these columns as it is Mr. Arnott's intention to repeat his address at some future meeting of the foundry trade. "It is a lecture that has taken a considerable amount of preparation," declared Mr. Goodwin, who proposed a vote of thanks to Mr. Arnott. "It reflects great credit on Mr. Arnott, who has studied both the customs and working conditions of the Continental foundrymen. It was a very big sacrifice for Mr. Arnott to travel all the way from Glasgow and return the same day, but it proved that he was a man who was desirous of imparting his expert knowledge to others."

Mr. Goodwin mentioned that he had also had the pleasure of visiting the Continent on several occasions and inspecting the various foundries. The last he saw was Krupps, in Germany. It was a very interesting visit, but still, after weighing up the whole position, he thought that England possessed quite as good workmen, in fact, better, but the trouble to-day seemed to be in finding work for the men to do. The way in which some of the castings were made was very interesting, and it led one to think that the founders of England might utilise cheaper iron instead of running out of their way and trying to adopt some with fancy names.

Speaking with regard to the plaster cast which was quite prominent in some of the Continental foundries, he reminded them that it was carried on to a considerable degree, and he was bound to admit also to an excellent degree, in this country, and especially in the Staffordshire district. Only last week, when he was in the Birmingham district, he witnessed the method in use. The material used, he said, instead of being plaster was actually sufficiently good enough to cast brass on it. As far as he could make out it seemed to be a mixture, and when he saw it he thought it might be a thing others could experiment with. Its base was of pitch. He thought it was a great advance on the old plaster cast.

The question of soft ramming arose, and Mr. Thornton, who has also visited Continental foundries, said he thought the secret of one successful founder could be attributed to soft ramming.

While it was agreed that some castings required more ramming than others, one speaker asked how did a man ram soft.

Mr. Thornton (President of the West Riding Branch) said that fourteen members had attended that meeting, and it had been so interesting that he was hoping that something could be arranged whereby the members of the East Midlands Branch might pay a visit to Yorkshire. He favoured inter-Branch meetings, as he was of the opinion they created the right sort of enthusiasm among the members which was all for the benefit of the industry.

If any member who visited the Newark meeting lost a silver wristlet watch he should communicate with Mr. H. Bunting, 82, Otter Street, Derby, as one found on the works of Messrs. Worthington-Simpson has been handed over to the care of the secretary.

Notes on Patternshop Management.—VI.

By Ben Shaw.

THE PATTERN STORE.

There is no perfect pattern-storing system, and much depends on the space available and also on the class of work. Not only must heed be given to the principles of convenience and system in storing patterns, but also to the protection of the patterns from destruction by fire. Ease in conveying patterns from storage to foundry is also a consideration, while the necessity of keeping an accurate record for the location of patterns, to prevent delay and confusion in finding them when needed, is especially pressing in a plant where the number stored is large. Desirable features under all conditions are insurance of the continuous and economical operation, flexibility of system, accessibility, and certainty of having the proper pattern at the right time.

In shops numbering their patterns consecutively as they are made, it is customary to assign patterns to the shelves in order of completion, excepting for large patterns and moulding-machine plates, which are placed in different and more accessible sections. Then racks and locations are arranged according to classes of work, new patterns are assigned to their location accordingly. Patterns are inspected as they are returned from the foundry, to determine whether repairs are necessary, and to see that all loose parts and core-boxes have been returned. Loose pieces should be tied up in bundles or tacked to the pattern with wire brads.

As to whether the book or card system is the better for pattern storing may be debateable. The chief thing is whichever system is adopted, that it be done thoroughly. When cards are used all essential particulars must be printed thereon, and Fig. 1 is a copy of a card which the writer knows from experience to have made for efficiency:—

PATTERN CARD (Brass).

..... Order No. ..... System and No.....

Pattern sent to Foundry. Date .....

Pattern Shop Signature .....

Description.....

Pattern No.	Name of Part.	No Off.	Material.	Where Stored.	Drawing or Sketch No.

Pattern returned .....

Brass Foundry Signature .....

Fig. 1

For some classes of work more details than those given on the above card may be necessary, and Fig. 2 form may be used.

It is advisable to have cards of different colours for different metals, thus yellow cards may be used for brass, and white for aluminium, red for iron and green for steel.

For a shop which very seldom builds the same thing twice, such as a shipbuilding concern, a speciality machine or engine works, etc., a different problem exists. It is next to impossible to divide the product into standard classes, so there is no simpler or more efficient way to keep track of patterns than to number them consecutively as they are completed, with a new series for each year. In every works a certain proportion of the patterns necessarily become obsolete. It is desirable to remove them to a separate storage or out-of-the-way section of the live storage. Casual or makeshift patterns, such as the millwright occasionally has made, generally find a resting place there. Some firms destroy such patterns immediately after the casting has been machined.

A Committee on Obsolescence.

A good suggestion we have heard made, that when the storage becomes crowded and no other room is available, a committee made up of the works' manager, sales' manager, and foreman patternmaker or foundry superintendent should determine which obsolete patterns are to be destroyed. This is a very important phase of pattern storage.

It is sometimes contended that the patternshop foreman should not enter the pattern-store, but the writer cannot undersand how efficiency can otherwise be obtained. The storekeeper should certainly be subject to the foreman patternmaker, who should have the deciding word as to whether an old pattern should not be used. There is no parallel between the pattern-store and the fitting-shop or machine-shop store, because in the latter case there is seldom any choice; a specified size of bolts or studs is wanted or a certain jig, and only those will do. In the case of the pattern-store, however, it would be ridiculous to place the foreman patternmaker in practically a subordinate position to the storekeeper.

Open Air Storage.

Discrimination should be exercised in deciding what patterns should be kept and what destroyed. It is not possible to keep large patterns inside a covered store, and these are usually stored in an open yard, which makes correct classification and recording difficult. This applies particularly to marine shops. Large steel patterns, for instance, turbine casings, etc., are heaped up in the yard and memory plays an important part in locating them. Apart from standard patterns, some firms destroy all patterns immediately a ship goes into commission, while others store all patterns for years, on the off-chance that a replacement will be necessary at some time, because it is very seldom that ship patterns can be worked in for other ships. The writer has seen large cylinder patterns brought in from a yard where they have lain for twenty years, but they were in such a condition that they could not be used. Those large one- and two-off patterns are not usually painted, and when they are exposed to the atmosphere for a year or two are quite useless It seems somewhat foolish, therefore, for firms to hoard patterns which occupy valuable space for years. Instead of doing this large patterns which are not likely to be needed again should be dissembled and the timber re-used. In this way a very great saving can be effected.

PATTERN CARD (Steel).

.....Order No..... System and No.....

Pattern sent to .....Foundry.

Pattern Shop Signature..... Date .....

Description.....

Core .....Boxes ..	Sweep .....Boards ..	Gauge .....Sticks ..	.....Strickles.	Drawing .....Boards ..	Lifting .....Lugs ....

Pattern No.	Name of Part.	No. Off.	No. of Order.	Conveyance.	Where Stored.	Drawing or Sketch No.

Patterns returned .....

Stores Signature.....

This card to be sent to Store when Pattern is at Foundry, and returned to Pattern Shop on receipt of patterns.

Fig. 2.

It is very seldom profitable to store skeleton patterns. In shops where many pipe patterns are made the plates and shape-defining grounds can be used many times, and can be easily dissembled. It is a commendable practice to allot a section of the patternstore to barrels and other pattern parts which are not identified with a particular job, but available for any purpose for which they may be suited. It is not necessary to record these, and searching may be necessary to find a suitable part. The foreman patternmaker must be careful, however, that more time is not wasted in looking for a pattern part than would be occupied in making it.

The Mnemonic System.

It may be worth while to describe the mnemonic system, although it is one of those systems that is perhaps more simple in theory than in practice. A mnemonic symbol is a group of letters arranged in order of significance so that a suggestive and definite comparison with the full name of the article symbolised is pictured to assist the memory. AT12F is a very simple example, and much shorter than most mnemonic symbols.

The vowel system is not a vowel system at all, and next to useless for practical application to even a small variety plant. Because the vowels I and O are so much like the figures 1 and 0, R is substituted for the vowel I and K for O. A pattern for a 12-in. diameter coupling would be represented by the symbol AK3, assuming that this was the third pattern made in this class. A represents shaft because it is the vowel after the first letter in the word shaft; K for coupling, because K has been substituted for O in the list of vowels. A factor which affects the permanency

of the vowel system vitally, as well as several other systems, is that different people call the same article by different names.

The ideal patternstore is a fireproof building conveniently placed in relation to the pattern-shop and foundries, with well-lighted corridors and racks arranged so that no space will be wasted. It is not possible to keep each pattern separate, and it is not necessary; if each floor is lettered or numbered, and each rack likewise indicated, the storekeeper should have no difficulty in finding a required pattern. In a marine shop stores a series of racks are allocated to a certain ship. Thus the s.s. *Fairplay* may have six racks on a certain floor. The location designation of a pattern would then be A (indicating floor) s.s. *Fairplay*, C (or a number), indicating shelf. These particulars would then be entered into a record book or on cards.

There are very large firms in this country which have no booking or card system for keeping an accurate record of the position of the patterns, but the number is gradually growing less. It used to be a general practice to rely upon one man's memory as to the location of patterns in the stores, and this man was not a patternmaker, but an intelligent labourer. It is advisable for the store-keeper to be a patternmaker because with the best system patterns have frequently to be found by comparison with a drawing. Further, it is quite common for the draughtsman to indicate several previous patterns from which a choice can be made in altering to a new design. To explain more clearly the point we have in mind, let us suppose that a 12-in. globe valve is required with a standard body. There may be in the store several suitable patterns, but only a skilled man can say which will require the minimum of alteration. Decisions of this kind are frequently left to the foreman, whose time can be better employed in the patternshop. If this store is properly organised the foreman should be able to hand a blue print to the storekeeper, who will look out the required pattern with all the alteration parts.

Stamping Pattern Identification.

It is customary to stamp all small and medium-sized patterns after they are finished in order that they may easily be traced at the foundry when required, and also for storing after they have been returned. When patterns are not painted especially the indents soon swell flush again, but with properly-finished patterns it is a long time before the description can be read. It is imperative that all loose parts of patterns should be properly stamped in order to identify them if they get lost. A pattern which will be dissembled completely at the foundry should have all its component parts correctly stamped.

Quite a lot could be said about pattern letters and figures that are cast on the work and very probably used to identify it afterwards in the works stores. In a large engineering works it would be quite impossible to identify castings unless item numbers as well as description and engine numbers were cast on each piece. Letters are also used to place the name of the maker on patterns for advertising purposes. Many kinds of letters are used, perhaps the most common being made of a tin and lead alloy, an iron runner being used, and also a metal mould. The styles of letters most commonly used are sharp Gothic and Roman, the size depending, of course, on the size of the pattern. This matter of lettering patterns is very important, and if the letters are not very distinct on the casting their usefulness is lessened.

In some patternshops burnt varnish is used for fixing letters. This may be satisfactory in some cases, and almost necessary on very small patterns, but pins are altogether better.

When pattern letters are cast in the shop it would be a labourer's or boy's task to keep up the stock, which should either be in the general store or the foreman's office, and an order form should be filled up for them as for screws or nails. The proper marking of the patterns is certainly as important as the storing methods. Let it be admitted that satisfactory storing is almost an impossibility, but if the highest efficiency is to be obtained from the patternshop it is imperative that there should be no delay in obtaining patterns from the store which are required for alteration or overhauling previous to being sent to the foundry. (*To be continued.*)

A Chapter of Iron Trade History.

Origin of a Famous Foundry.

By T. B. Fowler.

One of the most piquant chapters in the history of the iron trade in general and the development of the Soho works, with which the names of Boulton and Watt are inseparably associated, in particular, was provided by a quarrel forced on the famous partners by that masterful individual, John Wilkinson, known as the father of the iron trade. The circumstances are recalled by the bi-centenary of Wilkinson's birthday, which occurs this year.

Wilkinson was an uncommon man, combining with acknowledged genius a disposition hard as granite. In his work on "Iron and Steel in the Industrial Revolution" Thomas Southcliffe Ashton gives an illuminating sketch of his character. "His was a dominating, assertive nature," he says, "almost titanic in the force of its elemental passions; in its ambitions; its inflated egotism, and its capacity for hatred and revenge."

Watts, searching for materials for his engines long before he ventured to the Midlands and made his home in Birmingham, found in Wilkinson, who had then settled at Bradley, near Bilston, where he had built his first blast furnace, the only man capable of supplying him with satisfactory castings.

Growth of Acquaintance.

The acquaintance thus begun developed when the partnership of Boulton and Watt was established at Soho, where Wilkinson's mechanical skill and practical inventiveness proved of undeniable value during a long course of years.

As a matter of fact, Wilkinson joined Boulton and Watt as a shareholder in the Cornish Metal Company, and, apart from supplying the castings, he was one of the first to utilise the engines made at Soho in his own works. Watt thought so highly of him that he placed his own son under him at Coalbrookdale. A frequent visitor to Birmingham, with which he had an additional tie through his sister Mary, wife of Dr. Joseph Priestley, he was not only consulted on points of engineering difficulty, if not of directorial policy, but was constantly the guest of the partners at their own homes. Still more intimate relationships were established by the marriage of his brother William's daughter to Boulton's son.

But no considerations, either of family connections, sentiment, friendship, or business, could modify his conduct, cool his hot, impulsive temper, or restrain his vindictiveness when he became involved in differences. He was as blind to as he was reckless of consequences. To do him justice, he was perfectly conscious of his own deficiencies. "Peace is a most desirable thing," he once wrote, "and the more so to one of my constitution, who cannot be angry by halves. Resentment with me becomes a matter of business and stimulates to action beyond any profit."

Storm Clouds.

It was due more to the tact and forbearance of Watt and Boulton than to the tractability of Wilkinson that no serious friction arose during the early years of their association.

The genial informalities began to disappear and coolness to manifest itself with the entry into the Soho business of younger men. Disputes with other people in Birmingham indirectly contributed to the embitterment of Wilkinson's temper. But, strangely enough, his passion was most deeply stirred by the warmth of the friendship evinced by the Soho partners for his brother William.

The storm clouds first broke over the ironworks at Bersham, where the two Wilkinsons were in partnership. A dispute over the division of profits, and the extraordinary conduct of John Wilkinson in purchasing an estate adjacent to Bersham for the erection of competitive ironworks entirely on his own account, culminated in a rupture and an appeal to the arbitrament of the law.

William's action in engaging Boulton and Watt's attorney as his legal adviser turned his brother's anger against Soho. The utter recklessness and ruthlessness of the intolerant ironmaster, who could brook no fancied slight or opposition, was revealed in the quick and amazing succession of subsequent events.

Wilkinson, not content with slandering his erstwhile friends by unfounded charges of conspiracy, flatly accused them of attempting to seduce his workpeople.

Blow to Soho.

Boulton and Watt emphatically repudiated his insinuations, and did their utmost to effect a reconciliation between the brothers. James Watt sent a personal letter to his old friend John. But it was of no avail. Wilkinson, thoroughly determined to embroil Soho, ignored the communication, and added injury to insult by abruptly notifying the partners that Bersham works "were now closed by injunction, and that existing contracts for cylinders could not be executed."

At the time Boulton and Watt were entirely dependent upon the supply of cylinders from Bersham, and their consternation may be imagined when Wilkinson, not content with closing the works, dismissed the workpeople, and removed all the transferable plant. The position was still further aggravated by his peremptory demand for the payment of all outstanding debts.

Under an arrangement sanctified by time and friendship, a running account had been established between Wilkinson and Soho, Boulton and Watt crediting him with the materials supplied, and debiting him with the premiums due on engines in his various works.

When he forced the crisis Soho owed him £1,700, while his debt to Soho, represented by arrears in premiums on engines for the use of which no written agreement had been made, amounted to a substantial sum.

There was a characteristic touch of native inspiration and decisiveness in the measures adopted by Boulton and Watt for meeting the difficulty. They at once discharged their financial obligations, and transferred their orders for cylinders to another Coalbrookdale firm, but finding supplies unsatisfactory, resolved themselves to undertake the casting and boring of engine parts.

Important Evolution.

No time was lost in selecting a site for a foundry, a suitable position being found on land alongside the canal at Smethwick, plans were drawn up for an undertaking comprising a foundry, boring mill, smiths' and carpenters' shops, quays and dwelling houses for workpeople. So the famous Smethwick foundry, designed, as Mr. Ashton says, to become "a nursery of men of invention and industry," came into existence, the "rearing" feast being held in January, 1796, a date which gains additional historic significance from the fact that it marked the evolution of Boulton and Watt from inventors and consultants to constructional engineers and ironmasters.

Meanwhile, the Bersham Works, forced to auction, had passed into the sole possession of John Wilkinson. Then a surprising thing occurred. Goaded to desperation by his injuries, William Wilkinson disclosed the startling fact that his brother John had pirated the Soho partners' invention. On his own solicitation Boulton and Watt had accorded Wilkinson the privilege of making the vital "Nozzle" and other important engine parts, and investigations now showed that he had not hesitated to erect whatever engines he needed for his own works, nor had he scrupled to supply customers.

The Tyrant Cornered.

It is not difficult to understand the note of satisfaction which crept into a letter written at this period by Watt's son. The overbearing tyrant had at long last been cornered. "The terrific antagonist," says young Watts, "has lost with me all his terrors and the crafty daring . . . . dwindles down to something unworthy of contempt. His conduct in the whole of this dispute with his brother has been truly despicable, and many transactions have been brought to light which show that he has dealt so with everybody."

Application was at once made to Wilkinson for unpaid premiums totalling between £9,000 and £10,000. He met the younger partners at Soho and agreed to make full reparation.

Temperature Measuring of Molten Cast Iron.*

By H. T. Wensel and W. F. Roeser, Washington.

Introduction.

The temperature of molten cast iron may be measured by means of a thermocouple, an optical pyrometer, or a radiation pyrometer. Of these three the thermocouple gives perhaps the most satisfactory values, but involves the greatest trouble and expense.

Platinum to platinum-rhodium thermocouples, in suitable protecting tubes, can be used up to 1,600 deg. C. At high temperatures, however, they deteriorate rapidly and in molten iron any of the protection tubes now available have only a short life. The expense of replacing or recalibrating the couples and the labour and expense of frequently renewing the protection tubes rule out the rare-metal couple as an instrument for general use in molten iron and steel.

There is no upper limit to the range of usefulness of optical or radiation pyrometers. When used upon metals in the open, however, these pyrometers are subject to corrections which may seriously reduce their usefulness, unless these corrections be properly taken into account.

Optical and radiation pyrometers are usually calibrated to read correctly when sighted upon objects inside a hollow enclosure of sensibly uniform temperature, such as a furnace with an opening small in comparison with the area of the walls. Under such conditions, usually referred to as black body conditions, the pyrometer receives not only the energy radiated by the object sighted upon, but also energy radiated by other portions of the furnace and reflected by the object. In such a furnace the lack of energy radiated by a body is in every case exactly compensated by the energy reflected from the walls, since bodies which have a low radiating power always have a correspondingly high reflecting power. Under black body conditions, therefore, the light received by the pyrometer is independent of the radiating characteristics of the materials and depends only upon the temperature.

When sighted upon a surface in the open, a pyrometer receives only the energy radiated by the object itself, and, consequently, always reads low. The ratio of energy radiated by a surface in the open to that radiated by a black body at the same temperature is known as the emissivity of the surface. For example, the emissivity of an unoxidised iron surface is about 0.4, while the value generally accepted for iron oxide (solid) is about 0.9. At 1,400 deg. C. this corresponds to a correction of 110 deg. C. for iron and 15 deg. C. for iron oxide when observed in the open with an optical pyrometer. The corresponding corrections in the case of a radiation pyrometer are about four or five times as great as those given above. The indications of this instrument are, therefore, so greatly affected by changes in emissivity as to render it unsuitable for temperature measurements of molten metals in the open.

It has been the practice to apply the corrections recommended by Burgess[1] to observations taken on iron and steel with an optical pyrometer. Burgess recommends using the value 0.40 for the emissivity of streams of apparently clean iron instead of the value 0.37 for pure iron obtained by him[2] under laboratory conditions. He gives the emissivities of liquid and solid iron oxide at 0.53 and 0.92 respectively. Liquid slag is stated to have "a variable emissivity of uncertain limits, depending on composition, but probably usually ranging between 0.55 and 0.75." Table 1 contains some of the values for these substances obtained by various investigators.

There is some question as to whether observations made on pure iron and iron oxide under laboratory conditions are applicable to commercial foundry practice. One cannot be sure that the surface being observed is the same as one of those studied in the laboratory until this has been checked under actual foundry conditions. The values given by Burgess were obtained under laboratory conditions, while those of Fry and of Moeller were obtained under service conditions.

Greenwood[3] has reported numerous pyrometer readings taken during steel making and iron casting. His temperature measurements are all relative, however. He determined the emissivity of slag relative to that of iron. Using the value 0.4 for iron, he finds 0.56 as the emissivity of slag.

Recently Wenzl and Morawe[4] have obtained results which led them to the conclusion that an optical pyrometer requires a correction of only 10 deg. C. to indicate the true temperature of ladles and streams of molten cast iron in commercial work. For obtaining true temperatures in the furnace they used a rare-metal thermocouple protected by a quartz tube with an outer tube of carborundum (Silitrohr). For measurements in streams, the measuring junction of a platinum to platinum-rhodium couple was sealed into a thin quartz tube by means of a welding torch, forming a very thin protective coating to reduce thermal lag.

The carborundum tube, of course, was dispensed with here. They also used iron to contantan and iron to nickel couples with apparent success. The former failed at about 1,380 deg. C. and the latter at about 1,250 deg. C.

Simultaneous readings were obtained with a thermocouple inserted in the stream or ladle and with optical pyrometers calibrated for black body conditions. All the observations reported were taken below 1,380 deg. C., and resulted in corrections of about 10 deg. One observation at 1,370 deg., in which the optical pyrometer read 92 deg. low, was rejected because the observation was taken through a veil of smoke.

Wenzl and Morawe report also measurements made during the pouring of a 19-ton forging ingot. The optical measurements on the pouring stream yielded 1,420 deg. C., while the true temperature of the ingot just after pouring was 1,495 deg., or 75 deg. higher. They state that "this does not seem to rule out the fact that the correction factor hitherto used (in this case about 120 deg.) applies here because the steel must have experienced a cooling in the long time of pouring." While these authors have shown that the corrections to be applied below 1,350 deg. C. true temperature are small, their work should not be taken to indicate that the corrections above 1,400 deg. C. are of the same order of magnitude.

Recently Herty[11] and others working at the Bureau of Mines measured the true and apparent temperatures on a bath of pig-iron by sighting with an optical pyrometer on the free surface and on the bottom of a closed silica tube in a graphite casing immersed in the molten metal. They obtained a smooth correction curve varying from 95 deg. at 1,400 deg. C. to 120 deg. at 1,600 deg. C. They apparently made no readings below 1,390 deg. C. true temperature.

The results of Herty and of Wenzl and Morawe are not necessarily contradictory, even though Herty found corrections more than ten times as great as those of the other two. The temperature ranges in which these observers worked overlap at only one point, namely, the observation of Wenzl and Morawe on the 19-ton forging ingot, where the correction was found to be in agreement with Herty's results.

While it is, of course, desirable for some purposes to know the true temperature of iron and steel, the apparent temperature (uncorrected optical reading) would serve equally well for the purpose of temperature control if, at a given temperature, the optical reading were always low by the same amount. It has been the experience in some foundries, however, that the optical pyrometer readings in the neighbourhood of 1,300 deg. C. are not reliable even for temperature control. In one large pipe foundry, for example, it has been found that no trouble is encountered

Table 1.

EMISSIVITIES FOR $\lambda = 0.65$ (RED LIGHT).

Substance.	Temperature Deg. C.	Emissivity.	Observer.	Date.
Pure iron	800	0.63 solid	Bidwell[6]	1913
	1000	0.54 solid		
	1200	0.43 solid		
	1200	0.23 liquid (Undercooled!)		
	1400	0.38 solid		
	1400	0.31 liquid (Undercooled!)		
	1800	0.48 liquid		
Pure iron	700	0.27 solid	Bidwell[7]	1914
	1200	0.29 solid		
	1300	0.29 liquid (Undercooled!)		
	1500	0.35 liquid (Undercooled!)		
	1800	0.53 liquid		
Pure iron	1050	0.379 solid	Burgess[5]	1915
	1530	0.370 solid		
	1535	0.365 liquid		
Commercial iron and steel	1150–1700	0.45 liquid	Fry[8]	1924
Commercial iron and steel	750–1600	0.435	Moeller, Miething and Smick[9]	1925
Iron oxide	1200	0.63 solid	Burgess[5]	1915
	1610	0.53 liquid		
Iron oxide	800	0.98 solid	Burgess and Foote[10]	1915–16
	1000	0.95 solid		
	1200	0.92 solid		
Oxide on ordinary iron and steel	750–1500	0.6 solid	Fry[8]	1924
Oxide on stainless steels	700–1400	0.7 solid		
Iron oxide	1100–1600	0.9 liquid		
Iron oxide	840–1200	0.8 solid	Moeller et al.[9]	1925
Slags	..	0.55 to 0.75	Burgess[5]	1917
Slags	..	0.9	Fry[8]	1924

* A Paper read before the American Foundrymen's Association by approval of the Director of the Bureau of Standards of the U.S. Department of Commerce. The authors are respectively Associate Physicist, Chief of Pyrometry Sec., and Assistant Physicist, Pyrometry Sec., Bureau of Standards.

when pouring is done below 1,320 deg., or above 1,355 deg. C. apparent temperature, but around 1,340 deg. C. pouring at the scheduled pyrometer reading does not always produce the same result.

At the request of and in co-operation with the sub-committee on cast iron research of the American Foundrymen's Association, the Bureau of Standards undertook to determine the corrections to be applied to the optical pyrometer readings on molten cast iron with particular reference to the constancy of these corrections at a given temperature. It was requested that nickel and nickel-chrome irons be included in the investigation, as particular difficulty had been encountered in making optical pyrometer measurements on these irons.

Measurements in Commercial Foundries.

Some preliminary observations were made at the Lynchburg Foundry Company, Lynchburg, Va., in connection with some other work being done by the committee mentioned above.

Five distinct mixtures of cast iron were investigated. Optical pyrometers were sighted upon the surface of the metal in ladles to obtain the apparent temperature, and a platinum to platinum-rhodium thermocouple was used to obtain the true temperature. The thermocouple wires were threaded through two-hole porcelain insulating tubes and were protected by a porcelain tube inside of a graphite tube. The graphite tube was clamped at right angles to a long seamless steel tube to facilitate immersion in the molten metal. The thermocouples used were approximately 150 cms. long, of which a 50-cm. length was inside the protection tubes and the remainder in the steel tube. The thermocouple was joined to extension leads in the steel tube, thereby locating the cold junctions at a portable potentiometer which was used for reading the emf developed.

The optical pyrometers used were of the disappearing filament type made by the Leeds and Northrup Company. The corrections obtained, thermocouple reading minus optical reading in the range of 1,360 to 1,410 deg. C. (true temperature), varied from 90 to 100 deg. C., while in the range 1,280 to 1,360 deg. C., the corrections varied from 25 to 50 deg. C., indicating a higher emissivity at the lower temperatures. The results, however, were not conclusive. The apparatus and methods were in the experimental stage, and the conditions were not as well controlled as in the work carried out later.

Further tests were then made at the plant of the American Cast Iron Pipe Company, Birmingham, Ala. Here essentially the same apparatus and methods were used under conditions which were better controlled than at Lynchburg. Observations were also made on streams in a few cases. Instead of holding the iron in ladles for obtaining observations, the iron was poured into dry sand moulds, 10 in. in dia. and 10 in. deep rammed into a section of a 16-in. iron pipe. This was done to obtain relative cooling rates under uniform conditions and freezing points of the metal which were of interest to the foundrymen.

Several methods were used for obtaining measurements on streams. For observations on streams of special foundry iron, a 250-lb. ladle was supported under the runner and the iron permitted to run into and overflow the ladle. The thermocouple was held in the ladle and optical pyrometers were sighted on the stream entering and leaving the ladle. The average of these latter values was taken as the apparent temperature of the iron.

For observations on blast furnace iron the thermocouple was held in the molten iron at the slag dam and the optical pyrometer was sighted on the metal just as it flowed under the dam and into the runner.

Some observations were made on streams of pipe foundry iron by holding the thermocouple in the iron at the bottom of the stream entering a 3-ton ladle. The optical pyrometer was sighted on the stream at the lowest visible point. Other observations were made on the same iron by holding the thermocouple in a hand ladle held under the lip of the runner. Optical readings were made on the metal as it came over the edge of the ladle.

For obtaining observations on streams of monocast iron, a dam was built in the runner from the cupola. The thermocouple was held in a pool of metal ahead of the dam and the optical pyrometer was sighted on the stream as it came over the dam.

Table II.—*Temperature Readings taken Simultaneously with Thermocouple and Optical at Birmingham on Streams of Five Types of Irons.*

Type of Iron.	Thermo-couple. Deg. C.	Optical. Deg. C.	Difference. Deg. C.
Monocast	1372 (4)	1360 (4)	12
Monocast	1381 (3)	1360 (3)	21
Pipe foundry ..	1272 (4)	1249 (4)	23
Pipe foundry ..	1288 (4)	1261 (4)	27
Pipe foundry ..	1306 (5)	1293 (5)	13
Pipe foundry ..	1308 (5)	1283 (5)	25
Pipe foundry ..	1309 (3)	1295 (3)	14
Pipe foundry ..	1312 (4)	1294 (4)	18
Pipe foundry ..	1323 (6)	1310 (6)	13
Special foundry ..	1374 (5)	1359 (5)	15
Special foundry ..	1385 (5)	1319 (5)	66
Blast furnace ..	1425 (7)	1323 (7)	102
Blast furnace ..	1448 (5)	1341 (5)	107
American radiator	1452 (6)	1363 (6)	89
American radiator	1460 (5)	1371 (5)	89

Note: The figures in parentheses indicate the number of readings which were averaged to obtain the corresponding temperatures.

Some tests were also made on streams at the American Radiator Company, Birmingham, Ala. The thermocouple was placed in the mixer and optical pyrometers were sighted on the streams entering and leaving the mixer, the average being taken as the apparent temperature. The difference in temperature between the iron entering and leaving the mixer was always less than 20 deg. C.

Some of the results of these tests on streams are given in Table II. The corrections to the optical pyrometer for the true temperature range 1,270 to 1,375 deg. C. vary from 12 to 27 deg. C. One observation at 1,385 deg. C. gave a correction of 66 deg. C. The other observations in the range 1,425 to 1,460 deg. C. yielded corrections varying from 89 to 107 deg. C.

The observations on ladles at Birmingham are shown in Table III. All these observations were

Table III.—*Temperature Readings taken Simultaneously with Thermocouple and Optical at Birmingham on Ladles of Five Types of Cast Iron.*

Type of Iron.	Thermo-couple. Deg. C.	Optical. Deg. C.	Difference. Deg. C.
Monocast, Run 450	1190 (3)	1131 (3)	59
Monocast, Run 451	1197 (3)	1177 (3)	20
Monocast, Run 455	1196 (3)	1149 (3)	47
Monocast, Run 457	1238 (3)	1204 (3)	34
Monocast, Run 461	1178 (3)	1126 (3)	52
Monocast, Run 461	1249 (3)	1211 (3)	38
Monocast, Run 461	1337 (3)	1309 (3)	28
High carbon, run 459	1253 (2)	1208 (2)	45
Special foundry, Run 456.. ..	1143 (3)	1106 (3)	37
Special foundry, Run 462.. ..	1204 (4)	1171 (4)	33
Pipe foundry, Run 452	1182 (4)	1140 (4)	42
Pipe foundry, Run 454	1158 (2)	1132 (2)	26
Pipe foundry, Run 458	1248 (3)	1226 (3)	22
Low carbon cast, Run 460A ..	1297 (3)	1235 (3)	62
Low carbon cast, Run 463.. ..	1219 (3)	1189 (3)	30

Note: The figures in parentheses indicate the number of readings which were averaged to obtain the corresponding temperatures.

below 1,340 deg. C. true temperature and yielded corrections varying from 19 to 63 deg. C., the average of all these giving a curve with practically a constant correction of 40 deg. C.

The corrections to the optical pyrometer appear to be independent of the carbon content for total carbon contents from 2.76 to 3.77 per cent. On melt No. 459, which was run primarily to secure readings on an iron of high carbon content, it was impossible to secure more than two or three readings before the surface of the 3.77 per cent. carbon iron was completely covered with graphite.

The temperature ranges covered in all the above tests were not very wide, as they had to be limited to those of the iron coming from the cupolas in the ordinary routine of the plant. However, the results of these tests indicated that the emissivities of streams of ordinary cast iron were much higher below 1,375 deg. C. than above this temperature. In order to investigate this phenomenon on ladles, further work was carried out in the foundry of the Bureau of Standards, where it was possible to vary conditions at will and to thoroughly cover a wider temperature range.

Experiments at the Bureau of Standards.

Seven distinct types of cast iron were investigated in the experimental foundry of the Bureau. The iron was melted in a 300-lb. capacity electric arc furnace. To obtain the corrections for streams, a thermocouple was held in the iron in the furnace while the optical pyrometer was sighted on the stream flowing out of the furnace into a ladle. Previous experiments had indicated that the difference in temperature between the iron in the furnace and in the stream was of the order of 10 deg. C. No correction, however, was made for this.

The optical pyrometer was sighted on the stream from the front, there being no smoke whatever present during any of the observations reported in this Paper.

As soon as the ladle was filled, the thermocouple was transferred to it and simultaneous readings taken with the thermocouple and the optical pyrometer as the iron in the ladle cooled. The depth of immersion of the couple in the ladle was from 6 to 10 in. Observations on streams at low temperatures were obtained by holding the couple in the ladle while the optical pyrometer was sighted on the stream flowing into a mould, pig bed, or back into the furnace.

In order to determine whether the depth of immersion was sufficient, the thermocouple was immersed 4½ in. in molten copper. The thermocouple at this depth of immersion indicated within one degree the correct freezing point of the copper.

The thermocouples and optical pyrometers used in the tests at Lynchburg and Birmingham were calibrated both before and after the tests. One of the couples used at Birmingham changed 5 deg. in calibration, a *pro rata* correction being made for this. In the work done at the Bureau, all the measuring apparatus used was calibrated before and after each run. The maximum change observed was 4 deg. in the case of a couple which had been used above 1,600 deg. C. Usually the change was about 2 deg. C.

As a ladle of cast iron is allowed to cool from 1,500 deg. C. to 1,300 deg. C. true temperature, a marked increase in the surface brightness occurs. This change occurred in all the irons investigated at nearly the same temperature, approximately 1,375 deg. thermocouple reading. In some cases the change was very abrupt, the transition from a surface of the uniformly low emissivity to a surface of uniformly high emissivity taking place within ten or fifteen seconds. If the bright surface, apparently a solid skin on top of the molten iron, was removed by skimming, the surface would be temporarily "dark," but would again become uniformly bright usually before a satisfactory optical reading could be obtained. The phenomenon is very striking, the increase in brightness being almost 100 per cent. In other cases, bright patches would begin to appear and slowly spread to cover the entire surface. In such cases, readings were taken on both the bright and the dark portions for temperatures somewhat below the transition point.

In one case, on runs 6 and 9 on low nickel iron, the dark and bright portions persisted side by side from about 1,375 deg. down to the end of the run. This behaviour probably caused the difficulty mentioned by the A.F.A. in their request that this type of iron be included in the work. At the lower temperatures the brightest portions were observed, although these were usually streaked with dark. The optical readings on these runs are consequently lower than would have been obtained if clear patches of bright surface had been observed. In the case of the high and medium nickel irons, with or without chromium

runs 7, 8, 10, and 11, the transition was very sharp, the surface being uniformly bright from 1,375 deg. down to 1,250 deg., at which point the bright surface began to break up into dark and bright regions. Here observations were made on both dark and bright portions but only the "bright" readings were reported. The slight increase in the corrections at the lowest points of runs 8 and 11 are probably due to the fact that in these cases the bright film grew very thick toward the end of each run and an appreciable temperature difference may have existed between the top and bottom of the film.

Some of the temperature measurements obtained in the Bureau foundry are shown in Tables IV and V.

TABLE IV.—*Temperature Readings taken simultaneously with Thermocouple and Optical in Bureau of Standards Foundry on Streams of Seven Types of Cast Irons.*

Type of iron.	Thermo-couple. Deg. C.	Optical. Deg. C.	Difference. Deg. C.
Ordinary cast, runs 1 to 5 inclusive	1170 (2)	1134 (2)	36
	1232 (3)	1195 (3)	37
	1254 (4)	1211 (4)	43
	1272 (3)	1221 (3)	51
	1289 (4)	1243 (4)	46
	1312 (4)	1248 (4)	64
	1345 (6)	1281 (6)	64
	1375 (2)	1291 (2)	84
	1408 (2)	1311 (2)	97
	1422 (7)	1321 (7)	101
	1449 (3)	1340 (3)	109
	1466 (2)	1357 (2)	109
	1507 (4)	1383 (4)	124
	1534 (2)	1404 (2)	130
	1574 (2)	1446 (2)	128
	1659 (1)	1525 (1)	134
Low carbon, run 12	1303 (3)	1246 (3)	57
	1339 (1)	1270 (1)	69
	1523 (3)	1400 (3)	123
	1602 (5)	1455 (5)	147
Low nickel, runs 6 and 9	1338 (2)	1294 (2)	44
	1399 (2)	1293 (2)	106
	1458 (4)	1340 (4)	118
	1504 (4)	1386 (4)	118
	1532 (1)	1410 (1)	122
	1576 (5)	1436 (5)	140
Medium nickel, run 7	1199 (1)	1140 (1)	59
	1298 (2)	1234 (2)	64
	1445 (2)	1337 (3)	108
	1510 (2)	1400 (2)	110
High nickel, run 10	1233 (2)	1163 (2)	70
	1416 (2)	1315 (2)	101
	1509 (3)	1390 (3)	119
Medium nickel-chrome, run 8	1375 (2)	1300 (2)	75
	1400 (3)	1289 (3)	111
	1456 (3)	1327 (3)	129
	1629 (3)	1485 (3)	144
High nickel-chrome, run 11	1229 (2)	1164 (2)	65
	1572 (2)	1440 (2)	132
	1601 (3)	1466 (3)	135

NOTE: The figures in parentheses indicate the number of readings which were averaged to obtain the corresponding temperatures.

It was noted that with ordinary cast iron the corrections to be applied to streams did not show a sharp break. This may be explained by supposing that the surface observed is a mixture of light and dark portions, the result being the same as would be obtained if a ladle of the iron were vigorously stirred so as to keep the surface broken up. Above the transition point the surface is, of course, "dark." At low temperatures the corrections for the stream approach those for ladles. The streams observed at the Bureau were comparatively small and irregular. In large, steady streams, such as were viewed at Birmingham, the stirring action of the stream would be less and here the corrections are no larger than for ladles.

In streams of high nickel and nickel-chrome irons, large areas of uniformly high and low brightness could be distinguished side by side, these being the irons in which the bright skin formed quickly and hung together apparently as a comparatively tough solid film. The temperature range in which this could be observed on streams of these irons was comparatively narrow and the temperature of the stream could be estimated within a few degrees in this region merely by noting the presence of the bright patches among the dark.

Discussion of Results.

While it is comparatively easy to establish the change in surface emissivity around 1,375 deg. C. on cast irons, the explanation of the phenomenon is more difficult. One can only form a conjecture as to the composition of the surface. The transition may be from liquid to solid oxide or from liquid to solid slag. The emissivities around 0.4 obtained in this work at the higher temperatures, however, seem to indicate that there we are dealing with a clean iron surface. At lower temperatures it is probable that the surface is made up to a large extent, if not entirely, of iron oxides.

It is a familiar fact[12] that in normal Bessemer blows silicon is first oxidised and then carbon, while in blows that start at an initially high temperature the silicon is eliminated after the carbon. Similarly in a basic open-hearth heat, normally the phosphorus is taken out first and then the carbon, but by beginning a heat at a high initial temperature, the carbon may be removed first. This points to the fact that the oxidation of the carbon in cast iron takes place to a large extent at high temperatures. This, occurring at the surface, might produce conditions sufficiently reducing to maintain a surface of metallic iron. At lower temperatures, the oxidation of the carbon taking place to a negligible extent would permit the oxide to form on the surface.

Another explanation offered is that the transition at 1,375 deg. C. is from liquid to solid iron oxides. While the melting point of the various oxides of iron are all higher than this, we are undoubtedly dealing with a mixture or solution of FeO in Fe_2O_3 as shown by the work of Sosman and Hostetter. It is very likely that an eutectic would be formed melting in the neighbourhood of 1,375 deg. However, the emissivity values obtained above this point indicate that here we have metallic iron. Perhaps the best explanation is that the solid oxide formed below 1,375 deg. is comparatively insoluble in molten iron, while the molten oxide formed above this point goes into solution as fast as it forms.

With a little practice and judgment it is possible to determine when the iron is above or below the transition point without seeing the actual transition. The bright surface, below the transition point, is distinctly yellow and has a matte appearance, while above this point the iron has a mirror surface with a slightly greenish tinge. Where both bright and dark are present on a ladle, of course, no confusion should result, and when the surface is streaky, the correction made should be intermediate between large and small. In any case one can always skim off the surface and note how the brightness of the metal underneath compares with that of the surface which has been measured.

Where iron of a given composition is poured day after day the optical pyrometer should not give any serious trouble even in the transition range, provided the operator knows about the transition phenomenon and is on his guard.

The corrections to be added to apparent temperatures in order to obtain true temperatures will be found summarised in Table VI. The data in these tables are based on an emissivity of 0.7 below and 0.4 above the transition point, which are recommended as being a fair average of all available data.

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TABLE V.—*Temperature Readings taken simultaneously with Thermo-Couple and Optical in Bureau of Standards Foundry on Ladles of Seven Types of Cast Irons.*

Type of iron.	Thermo-couple. Deg. C.	Optical. Deg. C.	Difference. Deg. C.
Ordinary cast, runs 1 to 5, inclusive	1232 (4)	1193 (4)	39
	1288 (4)	1248 (4)	40
	1300 (4)	1260 (4)	40
	1349 (4)	1235 (4)	114
	1434 (4)	1314 (4)	120
	1526 (4)	1399 (4)	127
Low carbon, run 12	1312 (3)	1272 (3)	40
	1407 (2)	1354 (2)	53
	1537 (3)	1394 (3)	143
Low nickel, runs 6 and 9	1256 (3)	1210 (3)	46
	1336 (3)	1286 (3)	50
	1461 (4)	1329 (4)	132
Medium nickel, run 7	1207 (3)	1172 (3)	35
	1294 (3)	1234 (3)	60
	1332 (4)	1275 (4)	57
	1411 (4)	1303 (4)	108
High nickel, run 10	1246 (4)	1224 (4)	22
	1417 (1)	1303 (1)	114
Medium nickel-chrome, run 8	1282 (3)	1245 (3)	37
	1390 (3)	1285 (3)	105
	1529 (3)	1394 (3)	135
High nickel-chrome, run 11	1255 (3)	1207 (3)	48
	1371 (3)	1327 (3)	44
	1518 (2)	1387 (2)	131

NOTE: The figures in parentheses indicate the number of readings which were averaged to obtain the corresponding temperatures.

TABLE VI.—*Corrections to Optical Pyrometer in Deg. C. when used on Molten Cast Iron* ($\lambda = 0.65\ \mu$).

Apparent Temperature. Deg. C.	Below Transition point. True temp. Deg. C.	Below Transition point. Correction. Deg. C.	Above Transition point. True temp. Deg. C.	Above Transition point. Correction. Deg. C.
1160	1194	34	—	—
1180	1215	35	—	—
1200	1236	36	—	—
1220	1257	37	—	—
1240	1278	38	—	—
1260	1299	39	1365	105
1280	1320	40	1387	107
1300	1341	41	1410	110
1320	1362	42	1433	113
1340	1383	43	1456	116
1360	1404	44	1479	119
1380	—	—	1502	122
1400	—	—	1526	126
1420	—	—	1549	129
1440	—	—	1572	132
1460	—	—	1595	135

So far no work has been done on steels, but an analogous condition exists here. In fact, it was a knowledge of a similar phenomenon occurring at a higher temperature in the case of steels which, to some extent, led to the method of investigation adopted here. It is hoped to take up the problem of optical pyrometer measurements on steel in the near future.

Welding.—Some tests were made in the Swiss Federal Testing Laboratories at Zurich to determine the tensile strength of oxy-acetylene and of electrically welded joints. The gas welding had been done by Sulzer Brothers, and the electric welding by a leading interest using electrodes of its own manufacture. It was found that the properties of the weld material taken from oxy-acetylene welds corresponded more closely to those of the plate than in the case of electric welding. This indicates the basis determining the practice in the Sulzer Brothers' plant. When the finished work must be as uniform throughout as possible, oxy-acetylene welding is given the preference. If it is only desired that the weld should have a high elastic limit or high tensile strength without regard to toughness or ductility, electric welding is preferred.

The Relationship of a Foundry to an Engineering Works.*

By T. Walker.

Whilst Papers on metallurgy, mass production, detail of engine or machine construction, the improvements in the rates of cutting metals, and machine-shop economics have had much consideration, founding, which must be admitted to be the foundation of engineering industry, and which can effect more economies than any other branch, has received but relatively little consideration; whilst technical schools have sprung up with classes for machine construction and drawing, and general engineering practice, foundry work has been sorely neglected in the past. Locally, founders are all pleased with the step which has been taken in Middlesbrough to institute evening classes in foundry practice. The result of this neglect is that literature of the trade is somewhat limited, and many of the present methods are practically the same as those of twenty or more years ago.

It is proposed to deal with the subject under the following heads:—(1) Whether a foundry can be successfully managed as part of a manufacturing engineering business; (2) what determines the decision to build a foundry, and (3) having decided to build the foundry, the points to be considered.

Foundry as Engineering Plant Department.

As a rule a foundry is the part of an engineer's business about which the direction knows least, and it is the part in which the personal equation counts for more than in almost any other department. It has been the practice in engineering from its commencement for foundries to be run as independent businesses, and one would therefore naturally conclude that there must have been some important consideration that led to this development. It might well be argued that the founder's art is one requiring so much personal attention that success could only be obtained by devoting to it the entire attention of the heads of the firm, who themselves would need to be practical foundrymen.

Undoubtedly there is a good deal of risk in the foundry business, and skilled management is certainly required, and it might therefore be considered that an engineer tendering for contracts and basing his price for the work on the assumption that he would obtain good materials, would by buying his castings lessen the risk. It could be argued that castings were after all raw materials, like forgings, bar iron and steel, and the production of them was outside the province of an engineering works.

If, however, in spite of these statements it be admitted that there are no positive reasons why a foundry should not form a beneficial part of an engineering business, and that even as a man does not need to be a first-rate turner in order to manage a machine shop, so it is not necessary for a master to be an expert moulder to run a foundry.

Determining Factors for Creating a Foundry Department.

Control of the Foundry Facilities for Obtaining a Supply of Good Castings.—Everyone who has assisted in the management of an engineering factory realises the importance of getting materials ready well ahead of the machine shop, and how provoking and wasteful it is when certain parts are lagging behind the rest. Very often some of the castings are missing, and it requires much care and organisation to prevent this.

It may be generally noticed that the castings which make weight are delivered quickly and regularly, but deliveries of difficult and light parts are invariably behindhand. The peace of mind of the management is not increased by finding a large piece of work worth hundreds of pounds waiting for the arrival of a casting worth a few shillings. It does not necessarily follow that such omissions will not occur in the works' foundry, but there is certainly very much less likelihood of it happening, and if it should happen the omission is more rapidly made good.

Again, the stock of castings in the stores can be more closely regulated, and the system of maximum and minimum stocks introduced, which would often be impracticable without the works' foundry.

Reduction in the Cost of the Castings.—It may be laid down as a fairly safe rule that where large quantities of general engineers' castings are required, and where there is a good deal of repetition work, then the foundry attached to the factory, and specially designed for such work, will produce the castings at a price considerably lower than they can be obtained from outside. The outside foundry cannot, and will not devote so much attention or expend the amount of money necessary for all the many appliances that save money in such cases, as they are bound to remember that work may be taken away at any moment, rendering useless their outlay on the special appliances to suit the special work.

Presuming the castings required are not of the repetition variety, and that they alter fairly considerably in size and design from day to day, then the problem of reducing cost becomes more difficult, and a very important consideration is whether the quantity is such as will permit of production at a low price.

If accurate statistics could be obtained a chart might be prepared giving the weight of iron necessary to be melted each working week for any class of castings, to make the cost of production equal an average market price for similar castings. It may be accepted that to compete in cost against outside foundries it is necessary to turn out a definite tonnage per week. The amount of tonnage varies with the class of the castings, and it is the accurate determining of this quantity that ensures success or foredooms failure in the cost of production. An item which must not be lost sight of is the weight of castings.

The practice of rubbing cores is an old grievance. Very often the calculated weight and the actual weight vary considerably, and a good profit may often be made on the saving in weight, a matter which can be more closely controlled and dealt with in the works' foundry where there is not the same temptation unduly to increase the weight of castings.

Another point of importance is the advantage of being able to make purchases to suit market conditions, and to buy large quantities of raw material well ahead, if prices are favourable.

Improving the Castings.—It may happen that whilst sufficient castings can be procured outside the quality is unsatisfactory. There is little doubt but that the quality of the castings can be made more suitable for their purpose in the works' foundry. There is better co-operation between the designer, the patternmaker, the foundry manager and the works manager.

Further, the supervision of the purchase of raw materials being in the hands of the management, a better selection can be made to suit any special requirements. This question of quality is a most important one, bearing, as it does, upon the cost of machining, the casting and the general appearance of the finished articles when completed. The engineering-manufacturer is well aware of the necessary dressing, trimming, filling in, rubbing down, painting and varnishing which are necessary to give a satisfactory appearance to his goods, and the slow and costly process it becomes. However well it may be done no painter can fill in and finish off badly-moulded castings and give the nice clean lines of design which give a pleasure to the designer and to the commercial men of the business.

General Convenience in Having the Foundry in Close Touch with the Rest of the Works.—Quite apart from the regulation of the supply of castings there are some other important advantages in being in close touch with the foundry. The patterns can be watched more closely, repairs can be more promptly made, and the patterns kept in better condition. Outside foundries are often sore on the patterns, and this is due to the want of a little mending in time. Designs can be simplified and improved by watching the progress of the work in the foundry.

It is sometimes difficult to see clearly how the casting is going to look by examining the pattern, and it is a great advantage to have the patternmaker in conference with the foreman moulder when new patterns are being put in the sand for the first time. Such conferences often enable small unimportant changes of design to be made which must simplify the moulding, and thus lower the cost of production. The designer also has the advantage of seeing the work more in progress, and can correct and improve his work with less delay and cost.

Obtaining Greater Secrecy.—Without casting the slightest reflection on the outside foundry, it is obvious that the same secrecy cannot be maintained when the castings are procured from outside.

Desiderata in Foundry Construction.

(A) The Site to be Chosen in Relation to the Works, and the Surroundings.—The nature of the ground upon which it is proposed to build must be considered. The land must be as free as possible from water, otherwise there will be trouble in keeping it out of the floor. If there be any danger of water coming in from the surrounding land it is best to enclose the whole foundry by a concrete wall to a greater depth than the deepest casting likely to be made in the floor.

It is desirable to place the foundry so that its least objectionable side abuts any neighbouring property, and for this reason the cupolas, charging platform and blower room should be placed on the side farthest from the adjoining property as there is a danger of receiving complaints of dirt and smoke from the cupola and the noise from the blower.

(B) Design of Building.—Judging by a large number of foundries this question does not appear to have received due consideration. At best the foundry is a dirty place, and therefore the building should have greater consideration rather than less. For general engineering work a portion of the foundry is required for heavy work, and the remainder for light work.

To be able to deal conveniently with heavy work the building should have ample head room and be constructed with due regard to the strains arising from lifting heavy weights. Possibly the best design for most foundries producing castings of varying weights is to have one or more middle bays, the roofs of which are supported on built-up steel stanchions, which also support the crane rails. Further bays of a lighter design, arranged at each side for sand-mixing department and fettling room. Whether the whole building should be constructed as a skeleton in steelwork having the sides and ends filled in with light brickwork or other material, or whether the outer walls should be of substantial brickwork with only steel stanchions in the middle bay or bays, is a matter of opinion. The walls of a foundry should be pierced with a large number of windows, and should have a good deal of glass in the roof; this would, under ordinary conditions, give the foundry a well-lighted appearance. Foundries have a tendency to be dark, the floor being chiefly black reflects little light, and although many windows may require cleaning the advantage of light is well worth the expense.

(C) Management and Division of Labour.—This is a debatable question. It is possibly the best plan to have a head foreman who has complete charge of the foundry under the supervision of the works manager. The appointment of the under-foreman should be left largely to the discretion of the head foreman, and he should be consulted upon all materials required for the foundry, such as the brands of iron to be used, quality of coke, etc., it being understood that he is held responsible for the quality of the metal in the finished castings. Whether this arrangement can be improved upon by the intro-

* A Paper presented to the Middlesborough Branch of the Institute of British Foundrymen, Mr. Smith presiding.

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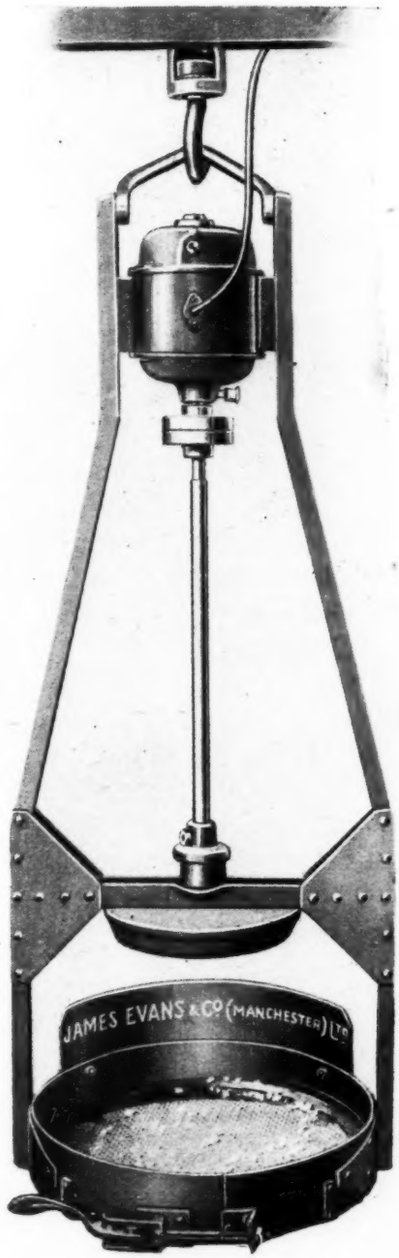

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duction of a metallurgical chemist is a matter for consideration. In some foundries a chemist has been appointed, whose duty it has been to take charge of the cupolas, the mixing of the irons, and to deliver to the foundry foreman the quantity of metal he requires in a molten state at pre-determined time. The system has much to recommend it so long as everything is proceeding smoothly, but when the wasters appear the trouble commences. Who is responsible for the bad work? However much care is taken to investigate the occurrence by a rational and practical inquiry it will be found most difficult to avoid "friction" developing between the foreman and chemist, especially if the foreman is paid a premium or bonus on the foundry results.

Possibly the best method to obtain the advantage of this system of working the foundry would be to have a foundry manager who would take complete control, and he would appoint and direct the chemist and the foundry foreman. When any wasters turned up he would decide the cause and deal with it accordingly.

It would be necessary for the manager to have the theoretical knowledge of the chemist and the practical experience of the foundry foreman, but unfortunately the foundry has seldom possessed any attractions to the mass of engineering students, who have, as a rule, been left out of the works curriculum, and therefore it it still difficult to obtain the type of foundry manager required.

However sound an ironfounder may be in theory and however skilful in practice, and whatever may be the standard of technical excellence which he may have reached in his operations, he can never have the satisfaction of feeling that improvement is no longer possible and that nothing further remains to be achieved as regards economy of production and quality of his castings. This is a distressing feature of ironfounding as a profession, and affects both the practical craftsman concerned with the mechanical side, and the business man concerned with the profit and loss side of the question. This position, however, is one that is inherent in the foundry business, so many factors bearing on success or failure being dependent on those unknown quantities which play so large a part in determining the result. The truth is that everything in ironfounding is variable, and practically nothing is constant.

The Question of Metal

The chemist who analyses iron or establishes an analysis, is not able to control changes of his material in the furnace, the ladle and the mould sufficiently to ensure an exact pre-determined result in the casting, nor can the physicist judge accurately of the qualities of a casting from test bars from the same heat of metal cast either separately or attached to the casting, for, in the one case the heat of the furnace, the amount and velocity of the blast, and other germane factors are not sufficiently under control to furnish an accurate record of the amount of carbon, silicon, manganese and sulphur which may be lost or gained during melting; and in the other case the susceptibility of the test bar to important physical modifications owing to variations in the heat of the metal, rate of cooling, temper of sand, native chilling qualities of the pig-irons used, etc., is such as to render it at the best but a rough approximation of the mechanical quality of castings made from the same mixture, so that even if it be granted that laboratory tests may be vastly helpful in a foundry and may ensure it against wide and serious divergencies of result, it could never be expected that in the case of any particular casting a specification based on chemical analysis and physical tests could be laid down which would yield the desired result with absolute certainty. All founders are painfully aware of this, for even the most successful will from time to time have a casting to make, the difficulties of which yield to no scientifically-established rules and are not overcome until after many failures and many discussions between foundry manager, draughtsman and pattern-maker.

In no place, perhaps, is the art of criticism practised more than in the foundry. The practice is one common to the trade. It might be to our advantage to give this subject some consideration and try to deduce from this reasoning why criticism is so prevalent in the foundry. One reason, and perhaps the chief reason, is owing to the varying nature of the work undertaken by the founder. It is quite common to see work coming into the foundry the like of which has never previously been seen and possibly may never enter it again, or if so years may elapse between the intervals.

It is difficult to see why this state of matters should exist. The author feels sure that all foundrymen will agree that it is the duty of the patternmaker to take his instruction from the moulder, before starting to construct the pattern, as to how the work should be moulded, and the patternmaker should embody in the pattern the moulder's instructions so far as they are practicable and in conformity with the design. If this arrangement were more generally adopted a better feeling would exist between these departments than that which sometimes is the case, and a great deal of talk would be averted, and better and cheaper work would be the result. In many jobs circumstances enter which compel certain courses to be adopted, and before one can judge with propriety concerning any piece of work he should be conversant with these circumstances, and also with the difficulties which had to be overcome in bringing the work to a successful issue.

—and of Design.

Small castings as a rule require much less consideration than heavy ones, for two reasons:—(1) It is not usual to demand high strength in small iron castings because the designer will usually make a section thick enough to permit of pouring the metal, and for small objects the sections are more than ample for considerations of strength; and (2) thin castings, by virtue of their more rapid cooling, are almost certain to be stronger per unit section than would be the case if the same metal were poured into larger and heavier sections.

Many large iron castings are of questionable strength and of doubtful reliability, even though they have not as yet broken in service, because of internal strains and lack of harmony between their contiguous elements. This may be true even though the casting is poured out of iron of the best quality, and may be due to inconsistencies of design occasioned by lack of foundry experience on the part of the designer, especially in the cooling and shrinking of the various parts of a large casting after being poured.

The physics of cooling, shrinking and synchronous contraction is a study which the foundryman should be better able to follow and to become expert in than the designer, and the engineering department of a manufacturing plant making iron castings of complicated shapes would do well to consult foundry conditions very carefully before finally determining upon and accepting designs for such castings.

The foundryman's knowledge of the physics of the foundry should qualify him to anticipate *some* things not generally known to the average draughtsman, and often not known to the supervising engineer.

The usual drawing office method is one of making assumptions in design by which sections of castings are regarded as beams of various sorts, loaded in various ways as pillars, as sections in tension and sections in compression, etc. These assumptions are made as though the members and sections were cold materials put together in such a manner as to allow each section to remain normal to itself, as would be the case in building up a bridge truss, securing member to member by rivets or pins. Unfortunately for such assumptions, the casting must go through the stages of molten, red-hot, and cold conditions before it is in its final form, and what happens during these changes of state may entirely upset the engineering assumptions upon which its members were calculated, and when the casting is cold some members which were expected to be in tension may be in compression, others that had been intended for compression may be actually in tension. It is therefore necessary in designing to consider carefully whether the casting, after having passed through these formative stages, will ultimately be as the designer assumes.

Cooling Conditions in a Casting.

The outer walls of a casting—that is to say, those which are more nearly adjacent to the sides, and radiating surfaces of the box, are naturally the first parts of a casting to lose heat, to fall in temperature, to begin to contract and decrease all their linear dimensions.

The inner walls of the same casting, being more isolated from the outer and conducting surfaces of the box, may remain hot for a much longer period than the outer portions; as a consequence, the outer members of certain castings may cool and take on their ultimate dimensions while the inner members are still hot. The latter will, of course, ultimately cool off by conduction, but they will also continue to contract until at normal temperature, and their freedom of contraction may be prevented by the already determined dimensions of the outer walls; as a result there is likely to be violent tension strains in the interior walls of such castings. Sometimes these strains are sufficient to cause rupture while the casting is in the mould. Sometimes the casting does not rupture until it is out in service, and even if it breaks in service the rupture may not be produced by stresses of engineering design, but may be due to the original non-synchronous cooling of the various parts of the casting.

There are some castings which by virtue of their shape can be speedily treated by the foundryman, and artificial cooling of certain critical parts may be effected in order to compel such parts to cool more rapidly than they would naturally do, and the strength of the casting may by such means be beneficially effected. As, for instance, in the case of a flywheel with heavy rim, but comparatively light arms and boss or hub, it may be beneficial to remove the moulding box and expose the rim to the air so as to hasten its natural rate of cooling, while the arms and hub are still kept covered by the hot sand, and their cooling retarded as much as possible. Or in the case of a flywheel with an ordinary rim and arm, but with a heavy hub, the hub may be exposed and compelled to cool more rapidly than it naturally would while the arms and rim are kept muffled in sand, and the synchronous cooling already referred to is at least approximated to a greater extent than if all parts were allowed to cool naturally.

It is often thought that the large fillets are fine features of design in work of this sort, but many times they are highly detrimental to good results where two walls meet and intersect, as in the shape of a T. If a large fillet is swept at the juncture there will be a pool of liquid metal at this point which will remain liquid for a longer time than either wall because of its lessened facilities for quick cooling, and this pool of liquid metal is bound to act as a feeder, supplying metal for other parts lower in the mould, that may shrink sooner, the result being, in practically every case, a draw at the juncture point, bad enough in any case, but made worse by the presence of the large fillet. Of course, there may be trouble from such intersections where no fillets at all are used, but the fillets should be kept small with the idea of allowing both walls and juncture to remain as nearly uniform in thickness as possible, and to have as nearly as may be the same capability of simultaneous shrinkage and solidification.

Other Difficult Castings.

Among other classes of difficult castings jacketed cylinders can be placed in the list of castings requiring careful consideration in design. In considering the case of a large oil-engine or gas-engine cylinder which is to be jacketed the inner wall which resists the strain of explosion, must be quite thick in order to afford the requisite strength against explosion pressures of ordinary nature, and also abnormal pressures due to pre-ignition and other causes. A cylinder of this sort, whose internal diameter might be 40 in., could well have a thickness of cylinder wall amounting to 3 in. or more. The outer wall forming the jacket has only to stand the ordinary pressure of cooling water, which might be quite low, often not exceeding town's pressure on mains, say, 80 lbs. per sq. in., and an outer jacket wall 1 in. thick might, on ordinary engineering assumptions, be regarded as ample to care for this pressure.

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If the cylinder wall and the jacket wall are continuous, that is to say, if each extends rigidly from one end to the other, there is likely to be trouble when such a cylinder is cast or cooled, and even if it does not break at the start it is quite likely to break in service later, because of the fact that a wall of metal 1 in. thick, located out near the sides of the flask which act as cooling media, will not shrink in time with the inner wall whose thickness is three times as great and whose opportunity for radiation is quite inferior.

It is reasonable to expect that the outer wall will cool first; will take on its final dimensions while the inner wall is still very hot; at a later period the inner wall shrinks to normal temperature and will find that its desire to contract is restricted by the compressive strength of the outer jacket wall, and the effect is a high degree of tension in the working cylinder wall. In such a case one good feature of design is to interrupt the jacket wall so that the inner or working wall may have its own way and be unhampered in contracting; afterwards it is closed up and rendered watertight by suitable mechanical means.

Coring Difficulties.

After the foundryman has accepted a design and begun the work he may have several things to do in order to produce a reliable casting. If it is a cored casting he must guard against the cores being so strong that when confined within the contracting casting they will produce rupture of the metal. Among the usual means employed for producing a collapsible condition of core may be mentioned the use of coke and ashes, horse manure, or a combination of them all, some of which ingredients will burn out as the casting cools, and provide thereby a collapse of the core. In other cases removable pieces, collapsible core arbors, straw around perforated barrels, and the like, tend to prevent castings from cracking because of an unyielding core.

In order to serve engineering purposes castings should be not only apparently sound, but really so, and to accomplish this purpose risers and sullage heads should often be employed on iron castings where they are not at present used.

Steel foundry conditions compel such precautions to insure soundness, but in ironwork cavities may exist without detection, and some of these may be avoided by the use of suitable feeding devices. If a pattern is not made so as to allow for sullage the upper side is likely not to be solid, because of the metal in the upper portions flowing or bleeding away from the interior of these sections to feed the shrinkage and contraction in the lower portions of the casting. Gravitation is at work here as elsewhere, and as the sections of the casting that are lowest cool and pass from the liquid to the solid state, the diminished volume of the solidified iron produces demands for fresh liquid metal from above to fill the voids, so that the upper portion of the casting is in such cases sacrificed for the benefit of the lower part. The top surface of such a casting may apparently be solid, but if drilled deeply, as for stud bolts or other purposes, it is likely that cavities and extreme openness of grain will be disclosed.

In some such cases, good can be accomplished by the use of chills applied locally. In some large castings intrinsic strength per unit section may not be a serious requirement. The amount of metal provided for reasons of mass, or other reasons, being so ample that the working strains per unit section are low, and are easily complied with, in other cases the engineering design may require high quality of material because high working strains are to be imposed upon the finished casting. In such cases engineering attention should be paid to the size of test specimens which are to furnish an index of quality, and to the relation which exists between the strength of cast iron when cast into light test-pieces, and that of the same metal when cast into heavy sections.

It is well that the foundryman be acquainted to some extent with the engineering purpose for which these castings are intended. This knowledge will enable him to pay particular attention to such points or parts of the castings as are specially critical, and to such as are to be machined. He can usually arrange to place his chaplets, etc., so as to clear the machined surfaces, and he can then better provide for producing a casting which is a clean one at these critical points. The moulder, if left to himself, may, and probably will, put chaplets directly in the path of a machined surface unless someone who knows better sees him and prevents it.

In ordinary cases designs for castings should be such that it will not be necessary for the foundryman to pay particular and extraordinary attention to special or heat treatment, because in the press of other matters such treatment may occasionally be forgotten and omitted, or it may be imperfectly done by inexperienced men.

Shapes.

It might seem almost unnecessary to say that shapes of sections, flanges and other projections should be so designed that the moulder may most easily produce the desired shape without having to use complicated means. If the designer or draughtsman were a man who had a little practical experience in foundry work he would see numerous opportunities for making shapes that would "draw" easily rather than certain other shapes that look well on paper but are much harder to produce.

Of course, the foundryman can produce almost any conceivable shape, if he has to, but engineering design is at its best when its shapes are at once suitable for the intended purpose and easily and cheaply produced.

On work of considerable size a little more time required to deal with a detail may prevent doing any pouring one day, with a strong probability that the moulder can make a job last him until the next night. The designer should put himself in the moulder's place and imagine himself making the mould in question, then he will see that a small difference in design sometimes causes a big difference in cost and risk.

Some of the difficulties have been outlined with the idea chiefly of calling more attention than is usually given to the relation which exists between good design and good foundry practice, and to some of the physical phenomena connected with the manufacture of complicated shapes in iron castings. Breakages are sometimes difficult to account for, and the designer may think the fault is with the quality of the iron, which may have nothing at all to do with the trouble, but the shape and design are the true cause.

If this Paper can have the effect of making the designers of cast-iron structures "sit up and take notice" of the foundry's physical problems *even a little*, it will have accomplished the purpose of its author.

The work of the patternmaker leaves him more scope for the exercise of initiative than almost any other branch of engineering. It is under his hand that the work of the designer first finds tangible expression. He is frequently entrusted with a large measure of discretion, and enjoys opportunities for intercourse and suggestion with the designer.

It is in the drawing office that the wishes of the customer first take their shape. Here it is also that a conception of the perfect finished article is formed. The skill of the draughtsman is of paramount importance all through the work, for he is in reality the Alpha and Omega of it. He provides on paper the idea of what the finished article is to be, and the finished article ought to be in metal the replica of what he has drawn.

The patternmaker generally meets with more difficulties than any of the other tradesmen connected with the foundry. He must understand the object of the draughtsman who precedes him and provide for the needs of the moulder who follows him, and it is false economy to attempt to rush this department at the expense of the foundry. The foundryman and patternmaker should be in close touch with each other, the former to point out the way in which certain patterns would be best made to suit existing tackle, or perhaps to overcome casting difficulties. Many times a strickle can be used for occasional jobs instead of a whole pattern. Patterns are sometimes made to make a certain way up, which on being cast prove defective on that account. Sometimes no doubt these mistakes arise through ignorance on the part of the patternmaker; *more often, however*, they occur through this department attempting to save itself time and trouble.

It is not in the interest of the employer that one department should prepare a piece of work a certain way in order to save trouble in that particular department, and to find that the work when it reaches another department causes no end of trouble, extra labour, and frequently bad castings.

It would seem to many that with all the advance made in foundry machinery for the production of castings on an economical basis, that the skill of the moulder should have advanced accordingly, but such is not the case. There are far fewer thoroughly good moulders to-day than existed fifteen or twenty years ago. This is due to the fact that in years gone by the moulder, in order to find and hold a situation, had to be able to make almost any casting in either loam, dry or green sand. Employers, realising this condition, influenced the beginner to serve long terms of apprenticeship, which as a rule gave him a constantly changing practice.

There are to-day but few shops, comparatively speaking, that can give an apprentice anything like a wide range of work in either loam, dry or green-sand moulding, from which to gain experience. The majority of founders to-day, being manufacturers of specialities, can at the best but let a boy pass through the limited range of work in their own shop, which is almost as nothing in many cases compared with the experience a boy could gain in many shops years ago. Consequently, there exist men who apply for situations as moulders who have probably worked for years from the same pattern, with the same boxes, and have carried on in the same monotonous fashion until they have become like automatic machines.

Give to such a man a job which requires careful handling, with, say, a few drawbacks or false joints, he is completely lost.

DISCUSSION.

Mr. F. P. Wilson, J.P., said Mr. Walker's Paper had raised an interesting question on engineering establishments running their own foundries. If the engineering plant was big enough and was engaged on specialised work it could be reasonably expected to run a specialised foundry successfully. He would not undertake to say that it would be run economically. One had heard suggestions in relation to the steel trade that different concerns might concentrate upon the manufacture of one class of goods, and each plant could be run in a most economical way, and this might also be made applicable to the foundries. In regard to a large engineering shop running its own foundry, everything depended on demand. The small shop could not run its own foundry economically. One had come across certain big concerns running their own foundries, he thought, at very high cost. If they would only pay that cost to outside foundries they would create a demand, and also get better work.

Mr. Walker said in dealing with engineering firms he was chiefly concerned with those engaged on special castings.

Mr. Smith considered that if the patternmaker knew a little more about the process and difficulties of moulding there would be a considerable amount of better work produced. There was a lack of contact between the patternmaker and the moulder.

Mr. Ridsdale, in a reference to Mr. Walker's suggestion respecting the various qualities of castings and the difficulties involved, said it was important that the quality of the material being used should be closely controlled; also the volume of the blast, the quality of the coke, and the system of charging. If these matters were carefully studied and controlled the quality of molten metal could be standardised.

Mr. Walker replied that he had known three chemists give a different analysis on the same metal, but Mr. Ridsdale replied that that could arise through analyses being taken at different times and when blasts were different.

Moving a vote of thanks to Mr. Walker, Mr. Wilson said the Paper had been full of interesting points, and had covered a great deal of ground. Urging Tees-side foundrymen to join the branch, Mr. Wilson said the officials were anxious that their membership should increase, so possibly in two years' time the Institute would hold its annual convention in Middlesbrough, and for that reason they wanted the branch to be strong and healthy.

F.T.J. 4.10.28

No. of Alloy	Specific Gravity.	Melting Point °C.	Test Specimen.	Average Tensile strength Tons/sq. in.	Average Elastic limit Tons/sq. in.	Per cent. Elongation on 2 in.	Remarks.
4	2.75	643	Sand cast	6.5	4.5	4	A light copper alloy which is an admirable substitute for soft brass. Is very ductile, and has a high shock resistance.
			Chill cast	9.5	5.0	8–11	
6	2.98	615	Sand cast	13.0	8.5	4	A copper-zinc alloy which is very strong, easily cast, and suitable for general purposes. It has excellent machining qualities.
			Chill cast	13.5	9.0	5	
6a	3.12	600	Sand cast	16.0	12.0	2	Stronger, but heavier than No. 6. Will take a very high polish.
			Chill cast	17.5	11.0	5	
12	2.83	629	Sand cast	7.0	6.0	2	A very reliable non-porous copper alloy. Is largely used for die-castings, as well as for sand castings.
			Chill cast	10.5	7.0	4	
38	2.88	622	Sand cast	9.5	6.0	5	A new copper-zinc alloy which, in view of its high tensile strength, has a remarkable ductility.
			Chill cast	11.5	5.5	13	
50b	2.72	645	Chill cast	9.0	6.5	13	A light nickel alloy which makes hard ductile castings, suitable for mathematical instruments, etc.
40d	2.67	587	Sand cast	11.0	5.0	10	A silicon-aluminium alloy having exceptionally good casting qualities, resistance to corrosion and great ductility.
			Chill cast	13.0	6.0	13	

The above figures are average test results made on specimens cast to 1 in. diameter and machined at the centre to 0.564 in. diameter.

The B.A.C. Foundry Data, of which this is Sheet A122, is available gratis.

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MOISTURE	under	1·50%

Trade Talk.

Messrs. Thos. W. Ward, Limited, Sheffield, have purchased the Union-Castle liner "Gascon" for breaking-up purposes.

Messrs. Heywood Brothers, iron and steel merchants and iron-ore importers, have removed, as from October 1, from Abbey House, Victoria Street, London, S.W.1, to Watergate House, York Buildings, Adelphi, W.C.2.

Resolutions designed to ensure that at no time should it be possible for control of the company to pass into non-British hands were unanimously confirmed at an extraordinary general meeting of the General Electric Company, Limited, recently.

Messrs. Short Brothers, Limited, and Messrs. Bartram & Sons, both of Sunderland, have each booked an order for a cargo steamer of about 10,000 tons for North East Coast owners. Both ships will be engined by Messrs. John Dickinson & Sons, Sunderland.

It is reported that a company is now being formed with a substantial backing to take over the business of Messrs. J. H. Holmes & Company, manufacturing electrical engineers, of Newcastle-on-Tyne, and that arrangements have been made whereby, in the meantime, manufacture will be continued and all customers' requirements dealt with.

Messrs. Callender's Cable and Construction Company, Limited, announce that their sales office for the London district has been moved from 113-117, Charing Cross Road, to 2, Surrey Street, Strand. The company has taken the whole of these premises and other departments will be subsequently moved there. The registered offices remain at Hamilton House, Victoria Embankment, E.C.4.

Imported copper plates, sheets, strips, and other rolled sections, rods and wire (other than insulated wire), and copper tubes are recommended for marking with an indication of origin by the Standing Committee under the Merchandise Marks Act. It is further recommended that the necessary Order in Council should come into force three months after the date on which it is made.

The English Electric Company, Limited, have received an order from the Bradford Corporation for a multi-cylinder 30,000-kw. turbo-generator, and also a repeat order for a 12,500-kw. unit of the same type from a private company. In addition, an order for two 10,000-kw. turbo-generator sets for the Yallourn briquetting plant of the State Electricity Commission of Victoria, Australia, has been placed with the firm.

The Central Electricity Board, it is officially announced, has placed contracts amounting in all to about £1,000,000 for the construction of 132,000-volt transmission lines in the area of the South-East England scheme, as follows:—For Part I, covering the northern portion of the area, with the General Electric Company, Limited; for Part II, covering the southern portion of the area, with Messrs. Callender's Cable and Construction Company, Limited. It is also announced that the Pirelli-General Cable Works, Limited, Southampton, presumably as subcontractors, have secured the contract for laying the line—approximately 300 miles in length—in connection with the scheme.

Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, have secured contracts for the construction of eleven broad-gauge superheated main-line locomotives and tenders for the Madras and Southern Mahratta Railway Company, and for 32 large superheated locomotive boilers for the Bengal Nagpur Railway Company, together with other locomotive accessories. Other contracts recently secured by this firm include locomotives for the Trinidad Railways, locomotive boilers for the Cordoba Central Railway, and locomotive spares for various home and foreign railways. These contracts will be carried out at the Scotswood Works, Newcastle-on-Tyne, and the locomotives will be shipped in fully erected condition, in accordance with the firm's usual practice.

The Grinding and Pulverising Offices of International Combustion, Limited, 11, Southampton Row, London, W.C.1, report that orders have recently been received for the following equipment:—For England, one 7 ft. by 36 in. and one 4½ ft. by 16 in. Hardinge ball mills for grinding tin ore, one hydrated lime plant for hydrating lime, two 4 ft. single-body tandem electric screens for screening coal, and one 3 ft. by 5 ft. single-surface electric screen for screening coal; for Australia, one 8 ft. by 48 in. Hardinge ball mill for grinding ore; for South America, two 8 ft. by 48 in. Hardinge ball mills for grinding gold ore; for Czecho Slovakia, one 5 ft. by 36 in. Hardinge ball mill for lead/zinc middlings; for Italy, one 8 ft. by 60 in. Hardinge pebble mill for grinding barytes, and one Raymond pulveriser for pulverising blue; for France, one cage mill with air separation for grinding lime; for Belgium, one Raymond pulveriser, and for Russia, one testing-sieve shaker.

Two Hunslet engineering firms appealed against their rating assessments at a meeting of the Leeds Assessments Committee recently. Messrs. Kitson & Company, Limited, of Airedale Foundry, objected to an assessment of £920 on erecting shops formerly occupied by the Leeds Tramways Department. On their behalf it was pointed out that an effort was being made to introduce into the city the building of a new type of locomotive. A great sum of money had been sunk in experiments, and the firm thought they were worthy of encouragement. Tests had been made with the engine on main lines, and a further and more severe test was to take place, when the engine would be engaged in hauling mineral traffic between Darlington and Starbeck. Even if the tests were successful, however, further experiments would have to be made, and it would be about two years before the firm would be ready to begin production on mass lines. The erecting shops were admitted to be in use, but only to a fraction of their capacity. The Committee reduced the assessment from £920 to £400. Messrs. John Fowler & Company (Leeds), Limited, appealed against an assessment of £7,078, an increase of £348 on the old assessment. The firm, it was stated, could not close down any particular shop because of the different processes carried on; and it was urged on their behalf that if the premises were now vacant they would be unlettable. Several Hunslet works had had to close down. The Committee decided to reduce the total assessment by £2,115—part of this for one year only.

Company Meeting.

Still Engine Company, Limited.—Meetings of the prior-lien debenture holders, 8 per cent. debenture holders, holders of the "A" shares, and holders of the ordinary shares of the Still Engine Company, Limited, were held in London recently, to consider resolutions approving a scheme of reorganisation. Mr. C. H. L. Cazalet, the chairman of the company, who presided, referred to the last occasion when the board brought forward a scheme of reconstruction. Unfortunately, he said, although some 70 per cent. of the debenture holders and shareholders were in favour of the scheme, the necessary three-quarter majorities were not obtained, with the result that the company had passed through a time of extreme difficulty, only avoiding liquidation by parting with some of its most valuable assets, and, further, they were obliged to put forward a very drastic scheme of reconstruction. The policy previously outlined of dividing up the business into its three main branches had now been carried into effect. This being the case, the board considered that now was the moment to face the facts by writing off the losses of the past and remodelling the business on a basis commensurate with its assets and prospects. The proposed reorganisation, far from being detrimental to the shareholders, was largely to their benefit, insomuch as not only would the prior charges now standing ahead of them be greatly reduced, but the arrears of interest accrued and still accruing on the 8 per cent. debentures, which amounted to over £20,000 on June 30 last, would be cancelled, and the company no longer saddled with this deadweight charge of roughly £6,000 each year. The scheme was unanimously approved at each of the meetings, and also at an extraordinary general meeting of the company as a whole. The eighth annual meeting followed, at which the chairman referred to the fact that, after satisfactory trials in March last, the motorship "Eurybates," fitted with 5,000-h.p. Still engines, had proceeded on her first voyage to the East. He looked to the merits of the Still engine being much more appreciated, and better results coming in the near future.

Obituary.

Lord Glenarthur, who died at Mauchline, Ayrshire, on September 30, at the age of 76 years, occupied an important place in the industrial life of Glasgow and the West of Scotland. He was chairman of the Lochgelly Iron and Coal Company, Limited, the Kinneil Cannel and Coking Coal Company, Limited, Robert Forrester & Company, Limited, and the Plean Colliery Company, Limited.

Captain Ernest H. Pease, a member of the well-known Durham family, died recently, at the age of 57. Captain Pease spent the greater part of his life in Darlington, removing to Bembridge, Isle of Wight, where he died, some few months ago, owing to ill-health. He was a director of the Cleveland Bridge and Engineering Company, Limited, and of Messrs. J. Shewell & Company's Successors, Limited, bridge builders and structural engineers.

Personal.

Mr. F. E. Powell, chairman of Ruths Steam Storage, Limited, and Mr. A. J. T. Taylor, managing director, have just returned to this country from a conference with Dr. Ruths and his engineers in Berlin, and from inspecting the progress made on the Ruths steam accumulator installation at Charlottenburg, the foundations of which are all in. This accumulator installation consists of 16 large vertically-arranged steel tanks, 70 ft. high by 15 ft. in diameter, and with a total capacity of 175,000 cub. ft., which provides storage of nearly 70,000 kw.

Wills.

Morris, W. C., of Aylesbury, ironfounder	£13,898
Fowler, J., of Sheffield, ironfounder ...	£17,160

Reports and Dividends.

Hopkinsons, Limited.—Interim dividend at the rate of 5 per cent., less tax.

G. Beaton & Son, Limited.—Interim dividend of 5 per cent. actual, less tax.

Ransomes & Rapier, Limited.—Interim dividend of 2 per cent. on the ordinary shares, tax free.

Stanton Ironworks Company, Limited.—Usual half-yearly interim dividend on the 6 per cent. preference shares.

Dobson & Barlow, Limited.—Final dividend of 6 per cent. actual, less tax, making 10 per cent. for the year.

Chesterfield Tube Company, Limited.—Dividend on the 7½ per cent. cumulative preference shares for the half-year ending September 30 was paid on October 1.

Neepsend Steel and Tool Corporation, Limited.—Profit, £39,442; final dividend of 3 per cent., less tax, making 6 per cent.; to reserve, £10,000; carried forward, £3,676.

Vulcan Foundry, Limited.—Final dividends for the half-year ended June 30 of 5 per cent. per annum on the preference shares and 8 per cent. per annum on the ordinary shares, both less tax.

P. & W. Maclellan, Limited.—The directors have decided to defer the consideration of a dividend on the 6 per cent. cumulative preference shares until after the completion of the company's financial year.

Hardy Patent Pick Company, Limited.—Brought forward, £9,852; net profit for year, £15,209; debenture interest, £1,650; dividend on the 7 per cent. preference shares, £2,100; dividend of 7 per cent. on the ordinary shares, £4,900; depreciation, £5,500; carried forward, £10,911.

Kayser, Ellison & Company, Limited.—Available balance, after providing for bad debts and including the amount brought forward, £29,674; year's dividend on preference shares, £6,000; depreciation of plant and machinery, £1,200; to reserve fund, £1,000; ordinary dividend of 5 per cent., less tax, £12,500; carried forward, £8,974.

Thos. W. Ward, Limited.—Balance at credit of profit and loss account, after charging directors' salaries, income-tax, interest and depreciation, £55,540; brought forward, £23,001; transfer from reserve fund, £25,000; final dividend on 725,000 old ordinary shares of 3½ per cent., making 6½ per cent., tax free; dividend on 375,000 new ordinary shares (May, 1928, issue) to June 30, 1928, of 6½ per cent. per annum, tax free; final dividend on employees' shares of 1½ per cent., making 6½ per cent., tax free; carried forward, £27,675.

Contracts Open.

Angora, October 25.—Points, crossings, rails and fishplates, for the Direction Generale des Fabriques Militaires. The Department of Overseas Trade. (Reference A.X. 6874.)

Hertford, October 19.—Supplying and laying 2,300 yds. of 10-in., 8-in. and 6-in. internal-diameter water mains, etc., for the Corporation. The Borough Surveyor and Engineer, The Castle, Hertford. (Fee £5 5s., returnable.)

Simla, October 14.—Pipeline and pump, for the Indian Stores Department. The Department of Overseas Trade. (Reference A.X. 6885.)

London, S.E., October 13.—Concrete mixer, for the Penge Urban District Council. Mr. A. J. Elson, clerk, Town Hall, Anerley, S.E.20.

Newton Abbot.—Supply of about 10 tons of 6-in. and about 10 tons of 9-in. cast-iron pipes, for the Rural District Council. Mr. S. Olver, highway surveyor, 9, Marlborough Terrace, Bovey Tracey.

Johannesburg, November 15.—Supply and erection of one overhead runway system, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 6851.)

"SERVICE GRC FIRST"

Eight fully insulated High Temperature Kilns in course of erection at Worksop, Notts., for use in the execution of orders placed with the General Refractories Co., Ltd., Sheffield.

ORDERS FOR REFRACTORIES

PLACED WITH THE

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SHEFFIELD,

PROVIDE EMPLOYMENT FOR BRITONS

AND A USE FOR

BRITISH GOODS

The General Refractories Co., Ltd., spends time, money and thought on spreading the idea

"BUY BRITISH GOODS"

The idea has caught on to such an extent that men now apologise to their wives for using foreign cars and to themselves for using foreign goods. The further and wider spread of the idea cannot do otherwise than benefit

BRITISH STEELFOUNDERS & ENGINEERS

☛ *The Company feels justified in asking for all-round support when orders for Refractories are being placed, and suggests that such support should only be accorded, in any case, to British firms, and, amongst those, only to firms who do not import and sell Foreign Refractories in competition with British goods.*

Monomark: "B.C.M. Refractory, London."

London Office: 92, CANNON STREET.
'Phone: City 8850 (Mr. A. C. TURNER).

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The opening of the final quarter of the year has brought little variation in conditions in the Cleveland iron market, consumers at home now rarely contracting beyond short periods, and then only for moderate tonnage, to which buying, as a rule, is mostly confined. With regard to expectations for the future, very little confidence is expressed in the political movement for the safeguarding of the iron and steel industries inaugurated at the Yarmouth Conference of the Conservative Party last week, the long period of delay which must necessarily elapse before such a measure could be put into actual force being regarded as an insurmountable barrier to any immediate improvement in the existing position. In the meantime, the month's shipments of iron from Tees-side ports make a slightly better showing on the export side, but are still a long way from comparing at all favourably with the totals of an earlier period. There is not, however, much accumulation of stocks in hand at makers' yards, the whole of the limited outputs at furnaces being about sufficient for current needs. Quotations are still unaltered, prices to both home and foreign buyers being as follows: No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge iron, 64s. 6d. per ton.

Conditions in the East Coast hematite market continue the improvement noted in recent reports, some fairly satisfactory sales having been negotiated with Sheffield, South Wales and Italian consumers during the current week. Prices are, however, still irregular, and although 70s. per ton is the recognised market quotation for mixed numbers, some business for export has been done at 72s. 6d. per ton c.i.f. Antwerp. On the North-West Coast prices have an upward tendency, Bessemer mixed numbers being quoted at 68s. 6d. per ton at works.

LANCASHIRE.—A more optimistic feeling has been in evidence of late in local markets for foundry iron, some of the leading furnaces in the Midlands reporting an appreciably freer tendency among users to place orders, with an increasing proportion of these relating to forward commitments. In the meantime, quotations are steady all round. For delivery Manchester or equal distance, Derbyshire No. 3 iron is at round 67s. 6d. per ton, and Staffordshire at slightly below this, while Cleveland is at 79s. Scottish is at from 87s. 6d. to 90s., according to brands.

THE MIDLANDS.—Consumers of foundry pig in the Black Country area are still pursuing a cautious policy in buying, and although orders are a little more plentiful than they were a few weeks back, the call is anything but good. The ironfounders do not find any great expansion of trade. Some of them are really very slack, and in the main they are disinclined to commit themselves for forward deliveries. Current quotations rule as follow:—Northamptonshire No. 3, 55s. to 56s.; Derbyshire, 59s. to 60s.; and North Staffordshire, 59s. to 60s., all f.o.t. furnaces. Scotch pig-iron prices remain firm at round about 90s. per ton delivered.

SCOTLAND.—The demand for Scotch pig-iron continues very slow, and the recent tendency towards improvement does not seem to make much progress. At the same time, prices continue firm, and makers are not inclined to make concessions even for parcels of moderate tonnage. Generally speaking, the founders are very quiet, and are not inclined to purchase ahead, although they recognise that pig-iron prices are more likely to advance than to fall.

Finished Iron.

In South Staffordshire and the neighbouring district there is still a dearth of business for crown and the cheaper grades of iron. None of the mills is able to find sufficient business to keep up anything like regular working, and there is keen competition between the iron makers in this area and those in Derbyshire and Lancashire for business which is developing. As a result of this competition, quotations differ to a wide degree, and anything between £9 and £9 15s. is offered. Nut and bolt iron is offered at between £8 12s. 6d. and £8 17s. 6d. delivered this area. There has been a further advance in the price of foreign No. 3 grade, which is now quoted at £7 5s. and upwards, delivered into the Darlaston district. Makers of Staffordshire marked bars continue to be fairly well occupied, but the price is unchanged at £12 at works.

Steel.

At Sheffield there is an improving demand for basic billets, while acid billets are to a large extent neglected. With the higher prices ruling for Continental steels, soft basic qualities of British manufacture can be bought at about the same figures as those ruling for the imported material, with the result that users are buying the home product in increasing quantities. Rollers of cheap steels have increased their quotations by at least 7s. 6d. per ton. For tinplates inquiries are moderately good, and a fair average of business is going through. Prices paid during the week range round 18s. to 18s. 1½d. basis for approved specifications, net cash, f.o.b. Wales.

Scrap.

The demand for foundry scrap material is still much below the normal season average, while prices in most markets are practically unchanged. In the North-East Coast area the foundries show a little more activity, but it is not yet reflected in any increased call for heavy cast iron, ordinary quality being still on offer at 60s. and machinery quality in handy pieces at 65s. In Scotland the cast-iron scrap market is still depressed, and for first-quality machinery cast iron it is difficult to obtain more than 66s., while for heavy ordinary cast-iron scrap suitable for foundries 61s. 3d. to 62s. 6d. is quoted. Old cast-iron railway chairs have again been sold at around 65s. to 66s., and light cast iron at 57s. 6d. to 58s. 6d., while for cast-iron furnace bars 55s. is being paid. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—The upward progress of values in the market for standard copper continues with steady persistence, as is emphasised in the fact that an advance of £11 per ton is now recorded as compared with the figures for the corresponding period last year. There is little doubt that consumers on both sides of the Atlantic have shut their eyes to the ominous tightening of the statistical position, and have allowed their stocks to become so slender as to fall below the margin of safety. The result is that all wish to bring their reserves up to the standard of security at one and the same time, so that all the United States refineries are shipping metal as fast as they can.

Closing quotations are:—

Cash.—Thursday, £64 10s. to £64 11s. 3d.; Friday, £64 8s. 9d. to £64 10s.; Monday, £64 12s. 6d. to £64 13s. 9d.; Tuesday, £64 12s. 6d. to £64 13s. 9d.; Wednesday, £64 10s. to £64 11s. 3d.

Three Months.—Thursday, £65 to £65 1s. 3d.; Friday, £64 18s. 9d. to £65; Monday, £65 2s. 6d. to £65 3s. 9d.; Tuesday, £65 to £65 1s. 3d.; Wednesday, £64 17s. 6d. to £64 18s. 9d.

Tin.—The steady recovery which took place in the tin market last week has, during the last few days, given place to an easing-off in values and prices have now sunk by as much as £5 for standard since Monday. This sharp rise may possibly have been due to reports from New York stating that there has been heavy business in the metal. It is also suggested in some quarters that the efforts now being made to rationalise the tin production in the Empire has had not a little bearing on the present trend of events in this metal.

Official closing prices:—

Cash.—Thursday, £224 10s. to £224 15s.; Friday, £225 15s. to £226; Monday, £227 15s. to £228; Tuesday, £224 to £224 5s.; Wednesday, £222 7s. 6d. to £222 12s. 6d.

Three Months.—Thursday, £220 7s. 6d. to £220 12s. 6d.; Friday, £222 5s. to £222 10s.; Monday, £223 10s. to £223 15s.; Tuesday, £220 17s. 6d. to £221 2s. 6d.; Wednesday, £220 5s. to £220 7s. 6d.

Spelter.—The market for ordinary spelter is still uneventful, despite the fact that consumers have perhaps shown a little more interest lately than during the last few weeks. Supply seems to be ample enough to cope with all demands made upon it, and prices have been no more than steady. The future of values will depend on the policy of producers, and in this connection it is rumoured that an endeavour will be made to regulate supplies.

Daily quotations are:—

Ordinary.—Thursday, £24; Friday, £24 1s. 3d.; Monday, £24 1s 3d.; Tuesday, £24 1s. 3d.; Wednesday, £24 2s. 6d.

Lead.—Values of soft foreign pig have pursued an even tenor, and there have been but narrow price movements. The announcement of the conclusions arrived at in the deliberations at the recent meeting of lead producers was received by the market with relief. The arrangements are reported to be eminently satisfactory, as there is to be no idea of restricting the market nor of forcing a return to uneconomic prices. There has been a steady flow of orders.

Closing prices:—

Soft Foreign Prompt.—Thursday, £21 15s.; Friday, £21 15s.; Monday, £21 15s.; Tuesday, £21 18s. 9d.; Wednesday, £21 17s. 6d.

Institute of Metals.

Programme for 21st Session.

The Council of the Institute of Metals has just issued the new session's programme of the Institute, and of its local sections in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield and Swansea. An outstanding meeting is that planned for March 6, when the "Coming-of-age" celebrations of the Institute will be held in London, under the presidency of Dr. W. Rosenhain, F.R.S.

Another interesting feature is the annual autumn meeting, which will be held in Düsseldorf in September. This is the first occasion that any British metallurgical society has held a meeting in Germany since 1914, and it is expected that the meeting will be largely attended by members from the Continent as well as from the British Isles.

The programmes of the six local sections of the Institute are very comprehensive and cover in all forty-two Papers and meetings. Several of the Papers will be discussed at joint sessions with other bodies, notably the Institute of British Foundrymen, the Institution of Engineers and Shipbuilders in Scotland, the Birmingham Metallurgical Society, and the Staffordshire Iron and Steel Institute. These joint meetings constitute an important new feature in the work of the local sections. First developed by the Birmingham local section, they have been extended by that section to cover the whole of its programme of ten meetings during the session.

A novel meeting is the one arranged by the London local section to discuss "Some Present-Day Metallurgical 'Tools' and Methods," the latter including the X-ray spectrometer, quantitative spectroscope analysis, high magnification microscopy, the dilatometer, and the preparation of some unusual metallographic specimens. Short addresses by various experts on each of these subjects will be given.

The North-East Coast local section strikes out a new line in planning an exhibition of metallurgical preparations and products, as well as a series of visits to works.

The Scottish local section has been fortunate enough to secure the President of the Institute—Dr. W. Rosenhain, F.R.S.—as one of its lecturers; he will deliver an address on "Alloys; Past, Present and Future."

Attractive programmes have also been prepared for the Sheffield and Swansea local sections, these covering a wide range of subjects from "Chromium Plating" and "Progress of Electric Furnaces," to "Pulverised Coal in Metallurgy" and "Recent Developments in Rolling Metal Strip and Sheet."

Altogether the programmes suggest that the Institute exhibits a considerable amount of youthful vigour notwithstanding its attainment of the age of 21, and they should result in the further strengthening of its membership, which is now verging on the 2,000 mark. Copies of the programme and invitations to the meetings can be obtained on application to the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

Sterling

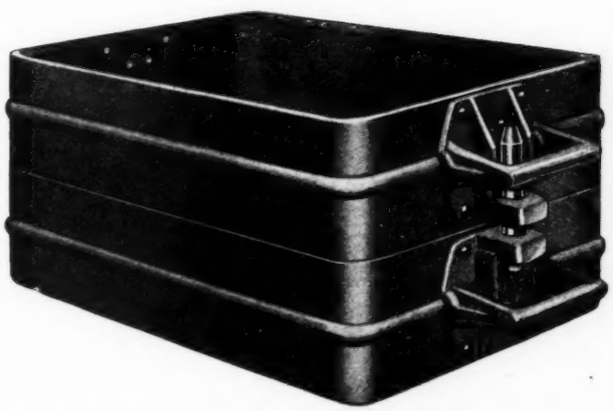
SOLID RIBBED ROLLED STEEL

MOULDING BOXES

are recognised as Standard Box equipment by the majority of the leading foundries and engineering establishments in this country and overseas.

Because they speed up production, save unnecessary labour, produce accurate castings and make for all-round efficiency.

If you are not a user of Sterling Boxes your competitors have the advantage of you.



STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone : 3345 BEDFORD.
Telegrams : "STERFLASK, BEDFORD."
Code : WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	64	10	0
Three months	64	17	6
Electrolytic	71	5	0
Tough	68	0	0
Best selected	68	0	0
Sheets	96	0	0
India	78	10	0
Wire bars	71	12	6
Do. September	71	12	6
Do. October	71	12	6
Ingot bars	71	12	6
H.C. Wire rods	75	15	0
Off. av. cash, September	63	11	3
Do. 3 mths., September	64	1	8½
Do., Sttlmnt., September	63	11	3
Do., Electro, September	70	1	0
Do., B.S., September	66	19	4½
Aver. spot price, copper, Sep.	63	11	3
Do., Wire bars, September	70	6	0
Solid drawn tubes			13½d.
Brazed tubes			13½d.
Wire			10d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	14d.
Rods, drawn	11½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	222	7	6
Three months	220	5	0
English	221	0	0
Bars	224	0	0
Straits	222	12	6
Australian	223	2	6
Eastern	223	17	6
Banca	225	17	6
Off. av. cash, September	215	15	7½
Do., 3 mths., September	212	17	3
Do., Sttlmt., September	215	15	3
Aver. spot, September	215	15	7½

SPELTER.

	£	s.	d.
Ordinary	24	2	6
Remelted	22	15	0
Hard	19	0	0
Electro 99.9	27	15	0
English	24	12	6
India	20	10	0
Zinc dust (Nom.)	35	5	0
Zinc ashes	7	15	0
Off. aver., September	24	11	2½
Aver., spot, September	24	9	11½

LEAD.

	£	s.	d.
Soft foreign ppt.	21	17	6
English	23	5	0
Off. average, September	21	18	2½
Average spot, September	22	1	0

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	33	0	0
Do. V.M. ex whf.	31	5	0
Rods	39	0	0
Boiler plates	29	0	0
Battery plates	30	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	59	0	0
Chinese	39	0	0
Crude	33	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	25	2	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£12 0 0
75%	£19 0 0
Ferro-vanadium—	
35/50%	14/- lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/2 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/8 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 7 6
6/8% car.	£20 12 6
8/10% car.	£20 12 6
Ferro-chrome—	
Max. 2% car.	£32 15 0
Max. 1% car.	£37 0 0
Max. 0.70% car.	£42 0 0
70%, carbonless	1/- lb.
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98/99%	£98 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80%, loose	£13 15 0
76/80%, packed	£14 15 0
76/80%, export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/8 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Hvy. steel	3	8	0	to 3	10	6	
Bundled steel and shrngs.	3	2	6	to 3	7	6	
Mixed iron and steel	3	0	0	to 3	2	6	
Heavy cast iron	2	17	0	to 2	19	0	
Good machinery for foundries					3	2	6
Cleveland—							
Heavy steel					2	15	0
Steel turnings					2	8	0
Cast iron borings					2	1	6
Heavy forge					3	10	0
Bushelled scrap					3	0	0
Cast-iron scrap					3	2	6
Lancashire—							
Cast-iron scrap	2	12	6	to 3	5	0	
Hvy. wrought	3	2	6	to 3	5	0	
Steel turnings	2	2	6	to 2	5	0	

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	52	0	0
Brass	38	0	0
Lead (less usual draft)	18	10	0
Tea lead	15	10	0
Zinc	16	0	0
New aluminium cuttings	64	0	0
Braziery copper	49	0	0
Gunmetal	49	0	0
Hollow pewter	150	0	0
Shaped black pewter	105	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/6
Hematite M/Nos.	70/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	78/6
,, d/d Birm.	86/-
Midlands—	
Staffs. common*	67/6
,, No. 4 forge	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3	55/6
Derbyshire forge	59/-
,, fdry. No. 3	59/6
,, basic	65/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3	64/-
Lincs. forge	62/6
,, fdry. No. 3	64/-
E.C. hematite	81/-
W.C. hematite	84/-
Lincs. (at furnaces)—	
Forge No. 4	58/-
Foundry No. 3	59/6
Basic	59/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	67/6
Northants foundry No. 3	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6 to 90/-
Glengarnock, No. 3	87/6 to 90/-
Gartsherrie, No. 3	87/6 to 90/-
Monkland, No. 3	87/6 to 90/-
Shotts, No. 3	87/6 to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.					10	5	0
Nut and bolt iron	8	12	6	to 8	17	6	
Hoops					11	10	0
Marked bars (Staffs.) f.o.t.					12	0	0
Gas strip					11	10	0
Bolts and nuts, ½ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	7	6	to 8	12	6	
Boiler plts.					10	10	0
Chequer plts.					10	12	6
Angles					7	17	6
Tees					8	17	6
Joists					7	17	6
Rounds and squares, 3 in. to 5½ in.					8	17	6
Rounds under 3 in. to ½ in. (Untested)					7	15	0
				and upwards			
Flats, over 5 in. wide and up					8	7	6
Flats, 5 in. to 1½ in.					7	17	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs.)					10	0	0
Black sheets, 24g.					10	0	0
Galv.cor.shts.,24g.	13	10	0	to 13	15	0	
Galv. fencing wire 8g. plain					12	10	0
Billets, soft	6	2	6	to 6	10	0	
Billets, hard	7	2	6	to 7	12	6	
Sheet bars					6	0	0
Tin bars					6	0	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 7½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.26
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	16.25
Basic	18.02
Bessemer	19.01
Malleable	19.01
Grey forge	18.26
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	32.00
O.-h. billets	32.00
O.-h. sheet bars	32.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.40
Sheets, blue an'l'd., 9 and 10	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/- to 35/-
,, furnace	19/- to 21/-
Durham and North.	
,, foundry	15/- to 15/6
,, furnace	14/-
Midlands, foundry	—
,, ,, furnace	12/- to 13/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/- to 18/3
,,	28×20 ,,	36/3
,,	20×10 ,,	27/3
,,	18½×14 ,,	19/-
C.W.	20×14 ,,	15/6
,,	28×20 ,,	33/6
,,	20×10 ,,	22/-
,,	18½×14 ,,	15/9
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£17 10 0 to £18 10 0
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£32 to £33
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to £6 0 0

all f.o.b. Gothenburg

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Sept. 27 ..	64	10	0	dec.	1/3
,, 28 ..	64	8	9	,,	1/3
Oct. 1 ..	64	12	6	inc.	3/9
,, 2 ..	64	12	6	No change	
,, 3 ..	64	10	0	dec.	2/6

Electrolytic Copper.

	£	s.	d.	
Sept. 27 ..	71	5	0	No change
,, 28 ..	71	5	0	,, ,,
Oct. 1 ..	71	5	0	,, ,,
,, 2 ..	71	5	0	,, ,,
,, 3 ..	71	5	0	,, ,,

Standard Tin (cash).

	£	s.	d.	
Sept. 27 ..	224	10	0	inc. 30/-
,, 28 ..	225	15	0	,, 15/-
Oct. 1 ..	227	15	0	,, 40/-
,, 2 ..	224	0	0	dec. 75/-
,, 3 ..	222	7	6	,, 32/6

Tin (English ingots).

	£	s.	d.	
Sept. 27 ..	223	0	0	inc. 10/-
,, 28 ..	224	10	0	,, 30/-
Oct. 1 ..	225	15	0	,, 15/-
,, 2 ..	222	10	0	dec. 65/-
,, 3 ..	221	0	0	,, 30/-

Zinc Sheets (English).

	£	s.	d.	
Sept. 27 ..	33	0	0	No change
,, 28 ..	33	0	0	,, ,,
Oct. 1 ..	33	0	0	,, ,,
,, 2 ..	33	0	0	,, ,,
,, 3 ..	33	0	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
Sept. 27 ..	24	0	0	dec. 2/6
,, 28 ..	24	1	3	inc. 1/3
Oct. 1 ..	24	1	3	No change
,, 2 ..	24	1	3	,, ,,
,, 3 ..	24	2	6	inc. 1/3

Lead (English).

	£	s.	d.	
Sept. 27 ..	23	5	0	No change
,, 28 ..	23	5	0	,, ,,
Oct. 1 ..	23	5	0	,, ,,
,, 2 ..	23	5	0	,, ,,
,, 8 ..	23	5	0	,, ,,

AVERAGE MONTHLY PRICES OF MARKED BARS (SOUTH STAFFS).

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897 ...	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0
1898 ...	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	8 0 0	8 0 0	7 11 8
1899 ...	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	9 0 0	9 0 0	9 10 0	10 0 0	10 0 0	10 0 0	8 3 4
1900 ...	11 0 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 10
1901 ...	9 10 0	9 10 0	9 10 0	9 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 16 8
1902 ...	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 7 6
1903 ...	8 5 0	8 5 0	8 5 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 8 9
1904 ...	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 10
1905 ...	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	8 1 8
1906 ...	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	8 15 10
1907 ...	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
1908 ...	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 5 10
1909 ...	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1910 ...	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1911 ...	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	9 10 0	0 10 0	9 10 0	9 15 0	9 1 6
1912 ...	8 10 0	8 10 0	8 10 0	8 15 0	9 0 0	9 0 0	9 0 0	9 8 0	9 10 0	9 4 0	9 0 0	9 0 0	9 13 8
1913 ...	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 14 4
1914 ...	8 12 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	12 0 0	12 0 0	12 7 6	12 10 0	13 10 0	11 5 0
1915 ...	9 0 0	9 0 0	9 3 0	10 2 0	10 15 0	11 10 0	12 0 0	15 10 0	15 10 0	15 0 0	15 10 0	15 0 0	14 18 7
1916 ...	13 10 0	13 10 0	14 13 0	15 0 0	15 0 0	15 0 0	15 0 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1917 ...	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	16 0 0	16 0 0	17 0 0	17 0 0	17 0 0	16 6 3
1918 ...	15 12 6	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	23 0 0	25 0 0	25 0 0	25 0 0	25 5 0	22 10 7
1919 ...	18 0 6	18 10 0	20 0 0	20 0 0	23 0 0	23 0 0	23 0 0	24 12 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1920 ...	26 17 6	27 0 0	28 0 0	30 5 0	30 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1921 ...	31 10 0	30 3 4	27 10 0	27 10 0	27 10 0	24 15 0	21 0 0	20 0 0	20 0 0	17 10 0	17 0 0	16 0 0	23 7 4
1922 ...	16 0 0	14 17 6	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 18 1½
1923 ...	13 10 0	13 10 0	13 16 0	14 7 6	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 5 3½
1924 ...	14 10 0	14 10 0	14 10 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	15 0 0	15 0 0	15 0 0	14 17 6	14 17 3½
1925 ...	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 0 0	14 13 4
1926 ...	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	—*	14 10 0	14 0 10
1927 ...	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 0 0	13 0 0	12 18 0	13 15 8
1928 ...	12 10 0	12 10 0	12 10 0	12 2 6	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	—	—	—	—

* No quotation available.

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